# GEOMETRIC PATTERNS IN ISLAMIC DECORATION

## A PARAMETRIC ENVISION OF PORTUGUESE AND AZERBAIJAN ISLAMIC GEOMETRIC MOTIFS

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## ABSTRACT

Portugal and Azerbaijan had a strong Islamic influence in the past. Even nowadays, we can experience signs of this cultural heritage, and the tangible and intangible impact in both countries. It is noticeable in many areas likewise in architecture.

In Portugal, despite many examples of Islamic heritage influence have been lost or destroyed, there still are in some particular cities a remarkable architecture and ornamentation legacy. On the other hand, the situation in Azerbaijan is slightly different due to the fact that the majority of Azerbaijan's population is Muslim. Therefore, there are still many living examples of Islamic geometric motifs in architecture and eventually, a living tradition.

The present dissertation is part of an ongoing research project entitled "Biomimetics and Digital Morphogenesis" enrolled at the CIAUD Research Centre of the Faculty of Architecture of the University of Lisbon.

The main focus of this work will be given to *girih* - a particular geometric pattern used in Islamic decoration, which can be found in a wide area from Portugal to Azerbaijan. The geometric patterns in Portugal were used mainly in "azulejos", "alfarge" and some stucco works, while in Azerbaijan, they are employed in different manners of designing mainly stone decorations and glass decorations on "*shebeke*" (an art of creating windows consisting of colorful glass and small wooden details attached without glue or nail using).

Nevertheless, all of the decorative elements deployed use a range of symmetries that have now been classified as belonging to distinct mathematical groups. But the subtlety and beauty of the designs are unparalleled in modern mathematical thinking and design.

Thus, our goal is to try to establish a relationship between the survey examples of Islamic geometric patterns in Portugal and Azerbaijan; to assemble a parallel between those decorative elements in both countries; and try to establish if there are some connections, similarities and the levels of correspondence.

Keywords: Islamic decoration, geometric patterns, Portugal, Azerbaijan, mathematics in Islam, Islamic philosophy, Islam

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*Aydan Aghabayli*
*Faculty of Architecture*
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*March*

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# INTRODUCTION

# INTRODUCTION

Islam as a religion that rose in the 7th century. Its territorial origins go back to Arabian Peninsula videlicet in Mecca. It was preached by Prophet Muhammad (c.570 – 632 June 8 CE), who was born in Mecca, which is still the most sacred city for Muslims. Later Muslims from all over the world started to make a pilgrimage there, which is called "*hajj*". When Muhammad was about 40 years old he started to receive revelations and deep insights and awareness that, as we know, according to Muslim's belief, angel Gabriel conveyed him as sayings from the God. All of that sayings memorized by Muhammad's companions are connected in the "*Quran*" - Muslim's sacred book. During this time he started spread the Islam. Later in 622, Muhammad performed a pilgrimage from Mecca to Medina, which calls "hijra" (emigration). He spent the rest of his life and passed away in Medina. At the time of his death, most of the Arabic peninsula was under the reign of Muslims. After the death of Muhammad the spreading the Islam through the world continued. Several caliphates were founded, followed by others in a dynastic system, materializing the occupation of new territories and spreading Islam in the Middle East, but also reaching as far as Magrib and Western Europe and later conveying Islam to places further eastwards, namely the Far East.

The first caliphate was Rashidun Caliphate (c. 632 June 8 – 661 July 28).

Actually, this term is just used to define the first four caliphs supervening the Muhammad. In other words, these caliphs are called "Rightly Guided". During the years of the reign of those caliphs, Muslim force spread over large areas from the north of the Africa to the west of Asia, including the totality of the Arabic peninsula.

During the conquests of the Rashidun Caliphate in 642, the first attacks on the territories of Azerbaijan started. Azerbaijan territories were under the rule of Sasanian Empire before those attacks. The Inhabitants of those territories professed, mostly, Zoroastrianism, but among the other religions were Babylonian, Christianity, Manichaeism, Judaism, Mandaeism, Paganism, Mithraism, Hinduism and Buddhism. During that conquest, Azerbaijan has suffered a large amount of changes in its cultural appearance, which are still strongly prominent. Through the fact that Azerbaijanis are still keeping Islam as its main religion in several field, the results of that impact, become permanent.

The first conquest of actual Portuguese territories (Iberian Peninsula) by Muslims started at 711 by Al-Walid I, *amir* of the second caliphate founded after the death of Muhammed – the Umayyad Caliphate ("*Califado Omíada*"). From 711 to 1249, the majority of what is nowadays Portuguese territory was under Muslim control. The Islamic caliphate and other political systems under Muslim rule, affected many fields such as language, social life, urban planning technology, agriculture, music, art and architecture. With the Christian conquest and the formation of Portugal as an independent kingdom, the role of Islam slowly decayed in time. Reason why we feel its less presence in Portugal than in Azerbaijan.

After these three caliphates, Islam continued to spread its dominance through of other caliphates such as those of the Abbasid dynasties, Safavids, Ottomans and Mughals.

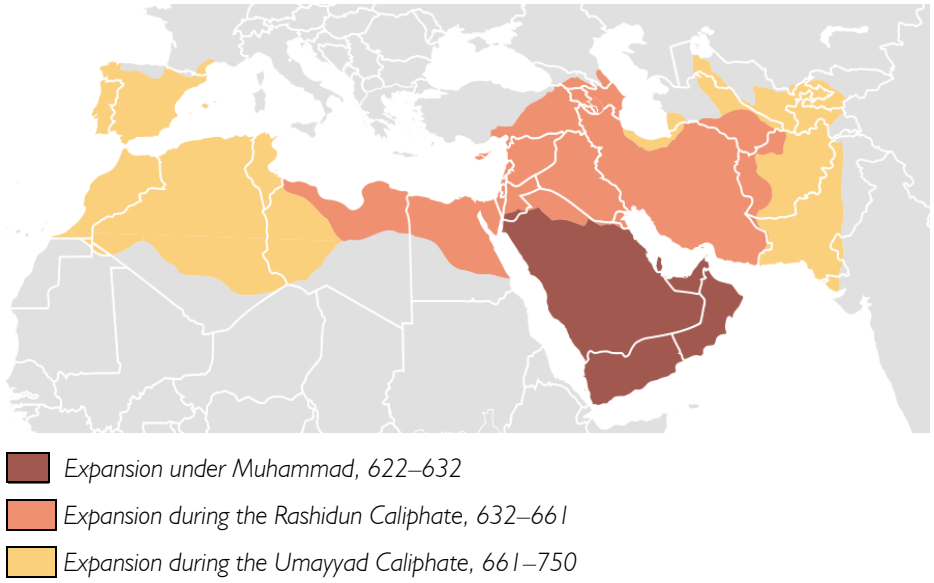



*Figure 1 Expansion of the caliphate under the Umayyads. (Photo from the website https://en.wikipedia.org/wiki/Umayyad_Caliphate#/media/File:Map_of_expansion_of_Caliphate.svg)*

As in every type of society, their ethnicity, moral and cultural values affect their practical life: Islamic society is not an exception. It is almost impossible to understand Muslim art and architecture without understanding its philosophy. Islamic art, as many scholars agree, needs to be studied through the relationships and parallels it establishes with science, philosophy and faith.

CHAPTER 1

# ISLAMIC ART

# 1. ISLAMIC ART

## 1.1. Islamic art and religion

At the beginning of its rather quick spread, Islam, as a religious and social project, did not have any art or architecture. The lifestyle and Islamic surroundings were based in nomadic and semi-nomadic tribes, proceeding with an extremely practical material cultural, mainly of portable implements and objects. Admittedly, at the beginning, Arabic merchants did not contacted the cultures of Byzantium or Persia, or even the culture of India. The art works they met on the road did not interest them as they used to lead a simple life. That is why it took about a century after the death of the prophet Muhammad to start forming Islamic art. In matter of fact, Islamic art originates in times of great conquests, as the new religion was spreading rapidly. They were conquering new territories, which were Christian territories before, and were Islamizing the population of those territories. Only after a completely new geographical stand-point, and within a political organized and framed society within the context of cities and sedentary communities and the pervading trade routes, the problem of art, or the institution of an artistic expression, began to flourish. Theirs was the space where they lived, now side by side with remaining strong traits of Greco-Roman art. The importance of perceptibility of Islamic presence on those territories become important from that moment on.

The Dome of the Rock in Jerusalem, built between 688 and 692, 60 years after Prophet Muhammad's death, is one of the earliest examples of Islamic art and architecture.


*Figure 2 Dome of the Rock Mosque. Jerusalem, Israel (688 - 692)*

There is still a strong tribute to byzantine art, but one can feel the Islamic presence in the choice of new elements that were then created. Later in Umayyad's Great Mosque (706 – 715 ) in Damask, we start to see Islamic architecture, if not in the small details, at least in its general forms. If we look at the residences and palaces of the Umayyad that were constructed nearby the Desert, we see how the Islamic art was started. Architecture of these residences seem like a mix between Roman fortresses and Sasanian palaces. Nevertheless, here we can surprise rather new elements. In first place the ornamentation, where inside of gorgeous classic compositions appear geometric and rhythmic motifs. They became a main theme in the decoration of those residences, namely in the Qasr of Mshatta or Mshatta palace. The façade element from that residence is shown now in Pergamon Museum in Berlin, Germany. It is a relatively small element from the entrance part of the façade of a monumental building,

*Figure 3 Fragment of the façade of the Mshatta palace (Qasr of Mshatta)*

The decorative ornaments of the façade shows us the first steps of Islamic art forming. In spite of Greco-Roman origins of the generic pattern and of the figurative imprints of the reliefs, we can observe here the use of geometric decorative elements. Here, zigzag lines diluted the classic Greco-Roman elements and give it a new look.

Islamic art was subjected to a lot of changes and influences during various periods of its development but at same time, keeping with its uniqueness.

Actually, the structure of the different manifestations of Islamic Art is strictly related to the *Qur'an* (the sacred book of Muslims) teachings. In Islamic world, *Qur'an* is ubiquitous. The daily life of a Muslim consists in the obedience of the *Qur'an* rules, praying to, and conversing with God: and all the fragments that make this rules and behavior are taken from the Sacred Book.

We know that art and architecture are fields directly related to people's life style, especially in those times this was more obvious. That is why the plastic art of Islam also is a reflection of Qur'an sayings.

In this sense Islam is one of the most relevant monotheistic religions in the world. There are five pillars of Islam what could be considered, as the first provision people who wants to become Muslim should admit. They are followings: "*shahada*" (faith), "*salat*" (prayer), "*zakat*" (charity), "*sawm*" (fasting) and "*hajj*" (the pilgrimage to Mecca). The first dogmatic principle in Islam is called *Tawheed* which is based on the most important key expression for Islam: *lā ilāha illā-llāhu muḥammadun rasūlu-llāh* (لَا إِلٰهَ إِلَّا اللهُ مُحَمَّدٌ رَسُولُ اللهِ ) "*There is no god but God (and) Muhammad is the messenger of God*". (transl: "*Não há outro deus senão Allah e Maomé é o seu profeta*"). It is called "*shahada*".

To become a Muslim a person should utter it.

For this reason, and based on the Surah's writings, Islam rejects the worship of idols and strictly prohibits the use of images of people or animals in Architecture and Art in general.

CHAPTER 2

# SPECIFICS OF ISLAMIC ART

## 2. SPECIFICS OF ISLAMIC ART

The absence of any images of living being (except for the vegetation) encourages believers to forget about the surrounding word and concentrate only in God, in his belief and in praying.

Thus, all ornaments in Islamic art were created to show the uniqueness of God, by using a modular system. Every detail and element in Islamic decoration have its meaning and a set of strict rules for its creation. It could be observed in all objects from the biggest to the smallest detail, from big architectural complexes to the small barely noticeable detail.

That powerful case in Islam naturally affects also its art. One of the *suras* says: "*Who created seven heavens one upon another. Thou seest not in the creation of the All-merciful any imperfection. Return thy gaze; seest thou any fissure?*" (Quran 67:3). It represents the perfectness and fulfilness of God and announces the methods of representing the worship of Allah as a path to perfection.

Geometric patterns started in Egyptian and Assyrian ornamentation. But its subsequent development reached its zenith in the highly sophisticated and intricate ornament of Islamic civilization.

Islamic builders and architects tried to create perfect schemes for everything. In architecture itself, they created shapes that could work for any type and function of buildings. This idealization is noticeable also on the tools used for decoration. Islamic ornaments had strict rules to be designed but at the same time, they had an infinite variety of possible combinations and patterns. The aim is avoid imprisonment with the earth forms. Reluctance to imitate any representation also creates abstract decorative forms.

In general, Islamic decoration is divided into 3 types: **geometric motifs**, **arabesques**, and **calligraphy**. See **Error! Reference source not found.**.

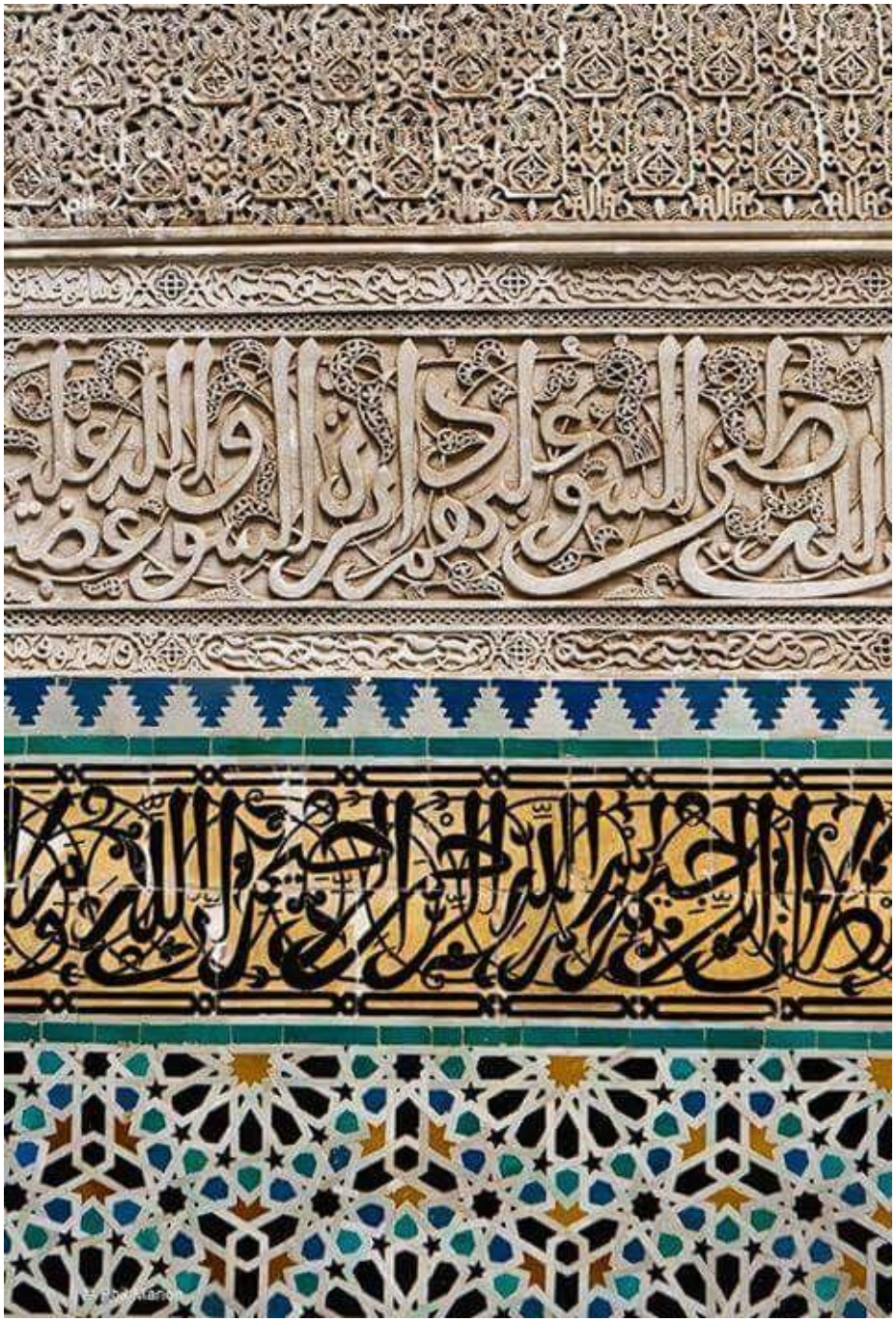


*Figure 4 An example of arabesque, calligraphy and geometric patterns in Islamic architecture. Morocco.*

## 2.1. Caligraphy

Every detail and element in Islamic decoration have its meaning and stresses the strict rules for its creation.

Consequently, Islamic **calligraphy** is considered as the most exalted among all the other decoration types, because it represents the visualization of the most sacred words and expressions from the *Qur'an* words, as all of those expressions are very important for Islam. In fact, the act of Creation was started from the words. The Arabic word "kun" (كن), which means the call *to exist* or *to be*. In *Qur'an* Allah (the God) commands *the universe to be* ("kun!" !كن). Then its echo created the universe, and it exists in Qur'an as a sound. *"Originator of the heavens and the earth. Whenever He decrees a thing, He says to it, "Be," and it becomes."* (Qur'an 2. 117)

The calligraphy (Quranic calligraphy) originates to times when Islam had started. It represents the response of the soul of Muslims to the divine message.

It is the most Arabic from all of the type of Islamic plastic art. Nevertheless it belongs to the whole Islamic world. Calligraphy combines the geometric accuracy with the melodic and soft rhythm. Thus, calligraphy has assumed different styles, shapes and techniques according to their regional location and era. And there is no Islamic calligraphy style that is out of use even nowadays. Islamic calligraphy as the highest point on Islamic ornamentation is a visualization of spiritual values contained in Islamic revelations. Thus according to the traditional expression in Islam calligraphy is a *geometry of the spirit*. The letters, words and poems (*sur'as*) of *Qur'an* are not just elements of writing language, they are creatures, the physical and visual shell of which is calligraphy. Those letters and words help to the person

reading Qur'an on connection with that sacred divine presence, which connection plays a big role in the life of a Muslim.

The term "Allah" used in this and other verses of the Quran refers not to tribal or ethnic god, but to the supreme Divine Principle in the Arabic language."(Nasr 2003)

Although the calligraphy during the process of its developments was acquiring several forms of script, which were not directly connected to the *Qur'an* text, something from the principal Quranic calligraphy continued to live in all its aspects.

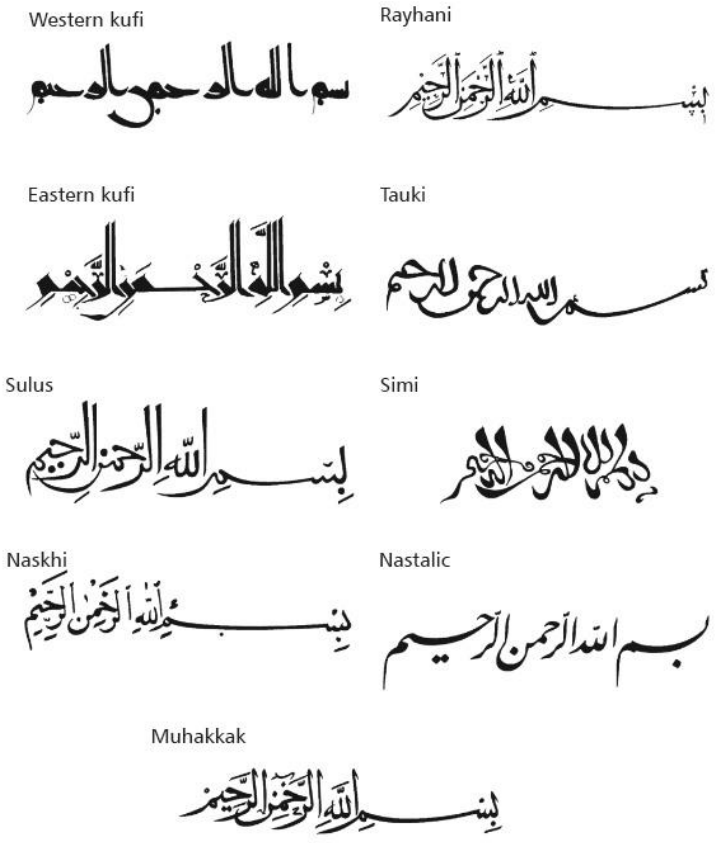



*Figure 5 Types of calligraphy styles. The Basmala (Bismillah) - the Islamic frase b-ismi-llāhi r-raḥmāni r-raḥīmi "In the name of God, the Most Gracious, the Most Merciful". (Photo from the book "**Исламское искусств и духвность**" )*

Since the first centuries of Islam existence, there were two writing styles: *Kufi*, which is distinguished by static nature of the letters, and *Naskhi* – variety of cursive handwriting with changeable fluidity. Kufi named because of the city Kufa - one of the centers of Arabic Umayyad's culture, and was often was used Qur'an calligraphies. It combines accuracy of the hatches with the geometric synthesis feeling.

*Kufi* handwriting gave a start to various types of calligraphic styles, which were used in architectural decoration. For example, rectangular Kufi - which was laid by blocks like bricks - ; Kufi with the flower decoration, - which was used mostly on book decorations - ; and Kufi with the twisted stems, which is the most used type, particularly in the art of chiseled plasterwork.

Each script was created following proportional standards. As a unit, they took a point, adequate to the point under the letter "ب" (ba). The highest vertical extension is equal to the height of the letter "ا" (alif), created of a certain quantity of points. The optimal horizontal length is equal to lower part of the circle the diameter of which is equal to height of the letter "ا" (alif),

Different ethnic layers become known regarding to their handwriting. Thus, Persians improved and developed a kind of pearl-like cursive, which they have used for translation their language to Arabic. Extremely different script types were used in Magrib: that was the type « of script that spread from the Iberian Peninsula to African Saheli. This type of script resumed a relatively ancient synthesis of Kufi and Naskhi.

Rich Turkish calligraphy does not differ substantially from Arabic: but with is symmetric repeating, it includes magical nodes and graphical emblems. It is interesting to notice also a connection observed between calligraphic styles of China and Sinkiang Muslims.

Regarding architecture, it can be observed on stone decorations, tiling, interior decorations, etc. It is often woven with arabesques. The most successful combinations are derived from the Kufi script with the vertical stems and vine. This connection between both themes and its merging, recalls the analogy that exists between two symbols: "*the Book of the World*" and "*the Tree of the World*". These terms are well known in Islamic philosophy. The first term - "*the book of the world*" originates in *Qur'an* whereas the second – "*the Tree of the World*" exists in various Asian traditions.

## 2.2. Arabesques

The second level in Islamic decorative motifs is the **arabesques**. Basically we could define arabesques as images of vegetation woven: stylized vegetal ornamentation with strict geometric interweaving. On the first look, they could be described as freeform patterns: but this is not true. All of those movements are designed in a perfect way by using geometric canons. It is creating by mirroring, repeating or multiplying one or several of the fragments of the pattern. Their repeated forms create a holistic composition. The limitless movement of the patterns can be stopped or continued in any point of the ornament without breaking any place of composition. Arabesques practically eliminate the background, as the Europeans like to call it "*horror vacui*". They could be located in any surface with any type of configuration: flat or convex.

Better said by Sir Ernst Gombrich, in a critical point of view towards this rather common expression: "*The urge which drives the decorator to go on filling any resultant void is generally described as* horror vacui, *which is supposedly characteristic of many non-classical styles. Maybe the term* amor

infiniti, *the love of the infinite, would be a more fitting description. Framing, filling, linking. Any of these procedures of 'graded complication' can point the way towards infinity, (…)*" (GOMBRICH, Ernst, *The Sense of Order. A study in the psychology of decorative art*, London, Phaidon, 1979 (1st ed.): 2012).
In the context of Islamic arabesque or geometric patterns the term coined by Gombrich seems quite to the point, as we witness here, and as we shall see, in portuguese glazed tiles, that same "*amor infiniti*", expressing the richness of creations, instead of a mere impulse of baroque nature. …

In this type of decoration, we can also find two main different types: the first one is always created in continuous rhythmic movement, while the second one is "crystal" in his nature.
Arabesques are the fundamental types of Islamic decoration. Historically arabesque in vegetal forms comes from the image of the vine. We find examples of ancient vine decoration used in arabesques while looking to one of the most ancient examples of arabesques in Mshatta palace. Vine in that ornament is associates with "the Tree of Life". They have reached the pick point of its development on the Renaissance period.
Arabesques could represent a large variety of plant types. It could be a palm tree, grenades, cones or flowers. All of them are connected in an abstract spiraling way. This abstract ornamentation existed in barbaric or nomadic nations, which conquest Europe at the beginning of middle centuries.
While arabesques reached its decorative perfection, it went back to its linear and rhythmic prototype, as in the first times of its creation.
Islamic ornamentation sometimes appealed to popular art. Examples of the popular art rarely preserved, but archaic forms sometimes unexpectedly appeared in Islamic art. It assimilates archaic motifs and brings them to

more abstract and common formulations. It can be said that it eliminates its magic sacral meaning and gives it new spiritual meaning.

In its more stylized versions, arabesque barely reminds vegetation, but in a sense, it transfers perfectly the rhythmic rules to language of visual images.

The second type or the property of arabesques is weaving. We meet perfect examples of it in Umeyyad monuments in the palace of Khirbat al-Mafjar and, above all, in the Great Mosque of Damascus.

In Islamic art, most of the ornamental motifs were primarily organized by stylistic solution. It is not any principal difference if these arabesque compositions are made on the wall or on the carpet; on the handwritings or on ceramics, the ideology will stay the same.

## 2.3. Geometric patterns

In our present dissertation work, we would like just to focus the third type of Islamic decoration – **geometric patterns**. Therefore, geometric patterns are arranged to show power and unity of Allah through their continuity and infinity of their shapes, symbolizing the ubiquity, almighty and the omniscient of God expressed in the Qur'an. Although there are a lot of different approaches to explain the origin and construction of these patterns. We aim to look at some of them through examples existing in Portugal and Azerbaijan. Geometric patterns are arranged to show power and unity of Allah through their continuity and infinity of their shapes.

CHAPTER 3

# ISLAMIC GEOMETRIC PATTERNS

# 3. ISLAMIC GEOMETRIC PATTERNS

## 3.1. The sense of patterns

According to the Islamic philosopher Al-Ghazali:

"*The visible world was created for connection with the invisible and there isn't anything in this world what is not a symbol of the other world*".

(Kuznetsov, 2004)

It means that everything was designed, not only in architecture but also in every field of Islamic art, has the specific role and every detail is important to the connection between the world we live and the world after death. As well, all of those patterns have sacral meaning. However, Islamic artists were not just determining the meaning of the patterns; they also made calculations for the perfect proportional structure of patterns. This was very important in the idealistic Islamic world.

The idea expressed by Al-Ghazali, meant that everything was designed, not only in architecture but also in every field of Islamic art, has the particular role and every detail is important to the connection between the world we live and the world after death. As well as all of those patterns have sacral meaning. But Islamic artists were not just determining the meaning of the patterns, and they also made calculations for the perfect proportional structure of patterns. These comparative studies were considered imperative in the idealistic Islamic world.

For a Muslim artists or craftsmen, which were decorating a surface, undoubtedly geometric forms seemed the most spiritually convincing. Because it was directly representing the idea of oneness of the God. This

oneness is underlying the diversity of the world. We could call this oneness inexpressible, because its nature prevents anything but itself, it is unique. It is reflected in the world due to harmony. Nevertheless, the harmony in turn being nothing than "unity in multiplicity" (*al-wahadah fi l-kathrah)*, the same as "multiplicity in unity" (*al-kathrah fi l-wahdah*). Interlacement expresses the one aspect and the other. But it is yet another respect that is recalls the unity underlying things, namely that it is generally constituted from a single element, a single rope or a single line, which comes endlessly back upon itself.

"*The Quran continuously emphasizes the doctrine of Unity and the Oneness of God, and it can be said that the very raison d'etre of Islam is to assert in a final and categorical manner the Oneness of God and the nothingness of all before the Majesty of that One. As the chapter on Unity (surat-al-tawhid) in the Quran asserts: "Say He God is One; God the eternally Besought of all. He begetteth not nor is He begotten. And there is none like unto Him*" (112:1-4).

In general Islamic geometric patterns are built on circles or squares base. They are that simple we could draw them with using just a ruler and a compass. Typically, repeated, overlapped and interlaced geometric shapes create complex patterns that consist of a number of polygons repeated many times.

The decorative elements deployed use a range of symmetries that have now been classified as belonging to distinct mathematical groups, but the subtlety and beauty of the designs are unparalleled in modern mathematical thinking. The base of the most geometric patterns could be four-, five- and six folded. All of the others could be constructed from those three types of folding.

In Islamic art, the geometric figure of the circle represents the primordial symbol of unity and the ultimate source of all diversity in creation. The natural division of the circle into regular divisions is the ritual starting point for many traditional Islamic patterns.

Harmony is the one of the first important criteria in creating geometric patterns. There are not any special field of science studying harmony. It appears in every detail of pure nature elements. Architects always tried to move this harmony from nature to their works. We could understand all their works as a representation of natural.

## 3.2. Symmetry

Symmetry is the one of the most important expressions of harmony. When we take a look to the philosophy or nature sciences, we notice that a symmetry could connect and balance the purposes of different schemes (patterns) for the human art.

Even in ancient Greek mythology dragons created a chaos, Gods created symmetry and harmony.

The decorative elements deployed use a range of symmetries that have now been classified as belonging to distinct mathematical groups, but the subtlety and beauty of the designs are unparalleled in modern mathematical thinking. Geometric patterns were used to represent the God, earth, human being, death and life in many cultures.

For example, a Japanese Buddhist Sengai Giben ( 1750 -1838 )who is famous by his writings and teaching used calligraphy and painting to make those teaching more accessible to people. One of the most famous of his paintings is an image of circle, a square and a triangle which represents: sky, man and earth. Despite of the fact he have left tis image without any inscription nearby this ink painting is called “The Universe”. He said about

his sketches: “My play with brush and ink is not calligraphy nor painting; yet unknowing people mistakenly think: this is calligraphy, this is painting."

*Figure 6 Painting "The Universe" of the Sengai Gibon ( 1750 - 1837 )*

Geometric figures are representing the universe not only in the East. In the art of the Ancient Greece and Medieval Europe, we see numerous examples of these figures, which are representing the universe. For example, we could see the famous “Vitruvian Man” painting from the well-known Italian artist, sculptor and architect Leonardo da Vinci (1452–1519 )

Titus Burckhardt, a scientist who studied Islamic art and architecture describes the spirit behind Islamic art like that:

A sacred art is not necessarily made of images... it may be no more than the quite silent exteriorization of a contemplative state.... It reflects no ideas but transforms the surroundings by having them share an equilibrium whose center of gravity is unseen.... Ornamentation with abstract forms enhances contemplation through its unbroken rhythm and endless

interweaving.... Continuity of interlacement invites the eye to follow it, and vision is transformed into rhythmic experience accompanied by the intellectual satisfaction given by the geometric regularity of the whole.... Study of Islamic art, or any other sacred art, can lead to a profound understanding of the spiritual realities that lie at the root of a whole cosmic and human world. (Burckhardt 1976)

The problem of drawing of ruled polygons is very important in Islamic geometric art. Mathematics of Islamic period inspired by Romans, used and then improved their techniques of constructing polygons. They did not think that old techniques work and had developed new ones. For example, Abu'l Vafa al-Buzcani have written in his works methods of how to draw heptagon with the fixed size of the compass. Polygons with seven and nine edges were the most difficult ones and the problem of drawing them was actual for that time.

However, the mathematics of the Islamic culture understood that it is not possible with the method written below and had written new works just for the construction of seven and nine edged polygons.

As we can see in the Figure 7 Abu'l Vafa explained the way of drawing seven edged polygon in a quite practic way very understandable and without any mathematical proof. Abu'l Vafa noticed that this method is an aproximate method but could be helpful on the construction.

It is interesting that the famous scientist Abu Rayhan al-Biruni also noted the importance of seven and nine related geometry, when he was observing flowers. He observed that petals of flowers while opening create a circle which in generally complies with the rules of geometry. It is difficult to find a flower with 7 or 9 petals, because through of geometric rules it is impossible to fit them into the circle by dividing in triangles. It is common to see a flower with three, four, five, six or eighteen but never seven or nine.

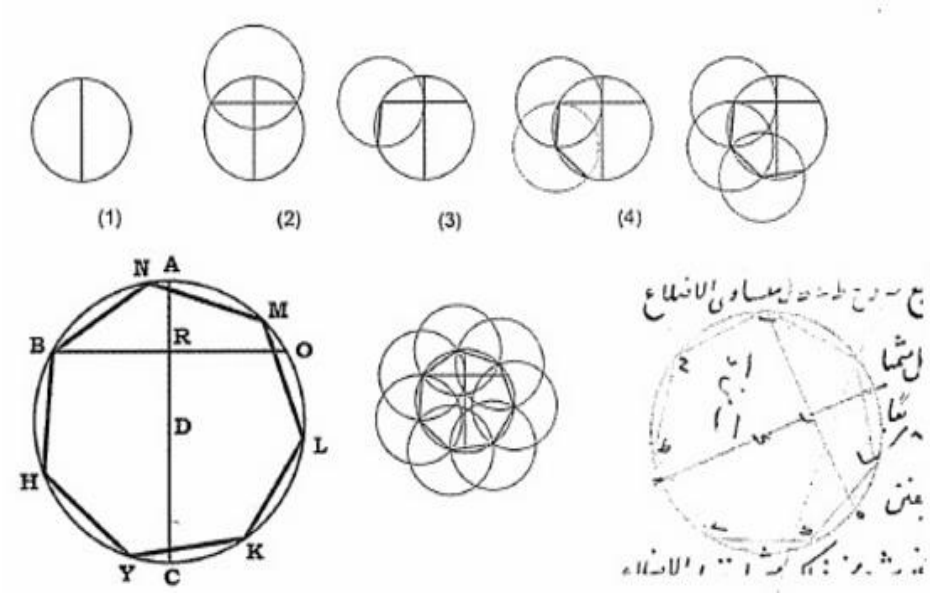



*Figure 7 An aproximate construction method of seven edged polygon by Islamic mathematic Abu'l Vafa. (Drawings by Husein Shen)*

The base of the most geometric patterns could be four-, five- and six folded. All of the others could be constructed from those three types of folding.

## 3.3. Nature and Geometric patterns

Natural assets always repeat itself on all progress steps. Thus, to learn harmonic methods of creation we should understand phases of nature creation. Even every hidden detail of nature sends us a message

### 3.3.1 Flowers

In the book "*The Hidden Geometry of Flowers. Living Rhythms, Form and number*" Keith Critchlow analyzes geometric approach of nature elements and flowers.

As we know everything in art and architecture take its start from nature. Symmetric flowers make it much more visible. As Critchlow says, a circle

naturally symbolizes a totality of space. It can also be seen as the circular flow of time, each point of symmetry marking an interval of time, like the hourly numbers and second marks on a clock face. (When the ancients measured time and angles in minutes and seconds they were acknowledging the complementarity of time and space.) The circle paradoxically is the natural expression of wholeness and oneness as well as the representative of the 'zero'. The most inexplicable conclusions derived from our analyses were the positioning of the points, usually on the embracing circle, from which the curvature of the petals could be struck as radii. A fine example of this migration of the centers from what would be considered natural comes from the careful analysis of the curvature of the six-pointed or six-petalled flower. The most familiar and naturally occurring pattern struck by a pair of compasses when tracing the curves, without changing the radius between the point and the scribing edge, is the six-petalled geometrical 'flower'. It is a fine example of profundity in simplicity. Sixness is the intrinsic nature of the movement (life) of a pair of compasses. The sixness of 'creation' is adequately symbolized in this most simple of geometrical exercises. (Critchlow, 2011)

*Figure 8 An example of Flower of life in nature*

This six-petalled geometrical flower appears in decorations of different cultures and could be found practically everywhere. It calls the Flower of Life, despite the fact that this pattern is rooted to historical period before Christ; the topologically this name is a new term in arts. It was an ancient Phinikkian symbol, which takes its origins of course from nature.

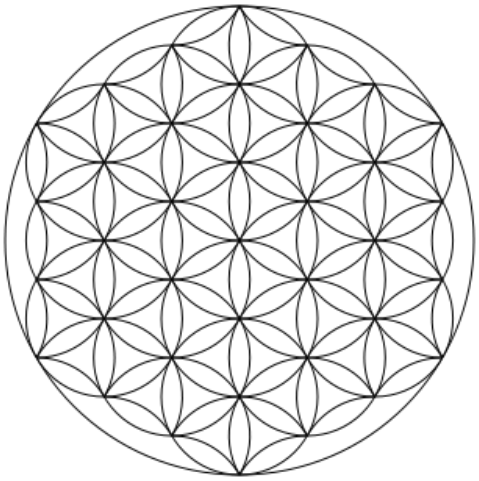


*Figure 9 Phinikkian ornament "Flower of life"*

One of the first appearance examples of those patterns is observed in the Idalium, an ancient city in Cyprus. It was used in the decoration of a cup with mythological scenes and war scenes on it; on the center of the cup was depicted "Flower of life" pattern. It goes back to XVIII – XVII centuries BC.

*Figure 10 Example of the ornament "Flower of life" in Cypus, Idalium*

In architecture, we meet an example in Egypt. The Temple of Osiris at Abydos have this symbol drawn in red ochre.

*Figure 11 The Flower of Life symbol drawn in red ochre Temple of Osiris at Abydos, Egypt. (Photo taken by Ray Flowers)*

In Islamic geometry it is used as a grid to construct girih ( Islamic geometric pattern). Most of the six and tvelve folded geometries were constructed on

this grid. These connected circles are used in different combinations and create a big variety of different patterns.

### 3.3.2 Light

Light holds a special place in Islamic philosophy and particularly in art and architecture. An artist who is going to represent the idea of the "unity of existence" or the "unity of the real" (wahdat al-wujud) actually has three facilities to do it. The first is geometry, which interprets the unity to the space language, the second is rhythm, which is opening the unity of the time and the third is light.

One surah of Qur'an (24. 35) says:

"*Allah is the Light of the heavens and the earth. The allegory of His light is that of a pillar on which is a lamp. The lamp is within a glass. The glass is like a brilliant planet, fueled by a blessed tree, an olive tree, neither eastern nor western. Its oil would almost illuminate, even if no fire has touched it. Light upon Light. Allah guides to His light whomever He wills. Allah thus cites the parables for the people. Allah is cognizant of everything.*."

It represents the divine light, which awakens things from the darkness of nothingness.

There is not more perfect symbol of divine oneness than light. Muslim artist wants to transfigure even the material he is working with to the light vibration. That is point to decorate interior and sometimes exterior surfaces of mosque or palace with ceramic mosaics. Often this decoration limits on lower parts of the walls, like that, the craftsman softens their hardness. It is also the reason of the transformation of their surfaces to perforating transmissive reliefs.

The colors show the internal richness of the light; through the coloristic harmony, we notice the true nature of the light.

The Alhambra palace – castle takes one of the first places among the examples of Islamic architecture which have fantastic light effects. Especially the Court of the Lions shows how the stone is turned into light vibrations.

*Figure 12 Sebka decoration and arches. The Court of the Lions. Alhambra palace. Granada, Spain (Photo from the website https://en.wikipedia.org/wiki/Court_of_the_Lions)*

The finesse and the elegance of decorative elements turn heaviness to a light form. Islamic ornaments and especially Spanish architectural element "sebka" contributes to this. Sebka is the one kind of decorative element, which is inherent to Spanish architecture, especially in Moorish and Romanesque/Gothic Mudejar architecture. They are rhomboid patterns that cover walls, columns, arches etc. of various structures in the arabesque relief. (Dodds, 1992)

## 3.4. Numbers and patterns

As the Islamic geometric patterns are created by using strictly rules. When we analyze them mathematically, we review many mathematical regularities. Numbers played an important role not only on Islamic geometric patterns but also on the whole Islamic philosophy. For example, the importance of the number eight is describing by Keith Crithchlow (2011) like that:

Eightness is inevitably associated with the diatonic octave and anciently with the planets visible to the naked eye. The relationship between the two was called the 'music of the spheres'. Eightness is sometimes called the auspicious number: it is a form of perfection of the earthly order, giving the four cardinal directions and their intermediates. The ear easily registers the eighth note in the diatonic scale as the octave. Eightness is part of the Fibonacci sequence as we saw, so it is likely to arise in the flower world —, which it does in particular in the beautiful flower known as Cosmos as well as in the Clematis and Lotus (to which we will be returning).

*Figure 13 Flowers Clematis and Lotus*

As we know the Fibonnaci sequence is a co-natural system of number progression which holds the key for a proportional and harmonious ratio:

0,1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144 etc, reported to the drawing of a spiral based in the *golden ratio*.

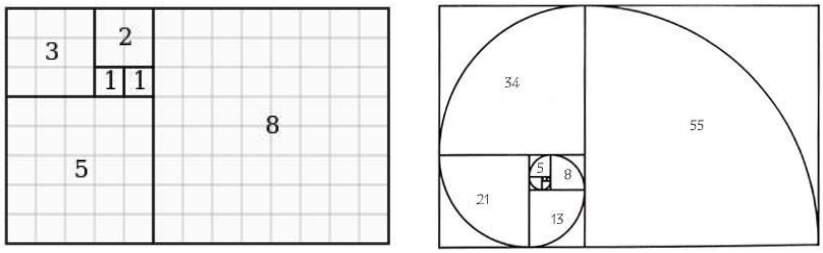



*Figure 14 The squares and the spiral in the Fibonaccci sequence progression.*

Eightness is associated with paradise. The word 'paradise' is of Iranian origin and means 'the walled garden', a clear reference to humankind's role as the gardener and cultivator of the green world of flowers. In ancient Persia, gardens were designed and divided into an eightfold pattern.

This pattern also spread to India. He found this symbolism best represented in Sa'di's Gulistan or 'Rose Garden', which is divided into eight chapters.

Not only is there a reference to eight paradises but Islamic mythology offers the model of there being eight angels holding up the throne of God. (From a Hadith of the Prophet Mohammed. A Hadith is a traditional saying recorded as being spoken by the Prophet.) Spiritual expressions of this number occur widely, the best known probably being the noble eightfold path of Buddhism. Maybe there is a connection between the vertical 8 and the horizontal sign of infinity?

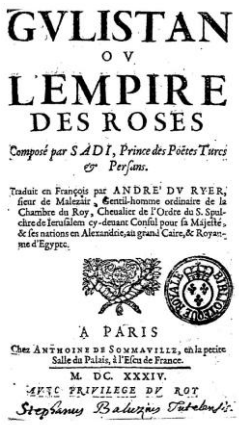

GVLISTAN
OV
L'EMPIRE
DES ROSES
Composé par SADI, Prince des Poëtes Turcs & Persans.
Traduit en François par ANDRE' DV RYER, sieur de Malezair, Gentil-homme ordinaire de la Chambre du Roy, Chevalier de l'Ordre du S. Sepulchre de Ierusalem cy-devant Consul pour sa Majesté, & ses nations en Alexandrie, au grand Caire, & Royaume d'Egypte.
A PARIS
Chez ANTHOINE DE SOMMAVILLE, en la petite Salle du Palais, à l'Escu de France.
M. DC. XXXIV.
AVEC PRIVILEGE DV ROY.

*Figure 15 Sa'di's Gulistan or 'Rose Garden' (illuminated mss , 17th century; French edition, 1804)*

When we go deeper to analyzing every pattern detailed, we get interesting results of ratios and relationships of patterns. Wasma Chorbachi, a scientist in the field of Islamic art, have written a lot of articles, folios and manuscripts on the topic of spiritual meaning of the geometric patterns and the mathematical approach.

Jay Kappraff in his book "Connections. The Geometric Bridge Between Art and Science" describes the method of Wasma Corbachi on one example:

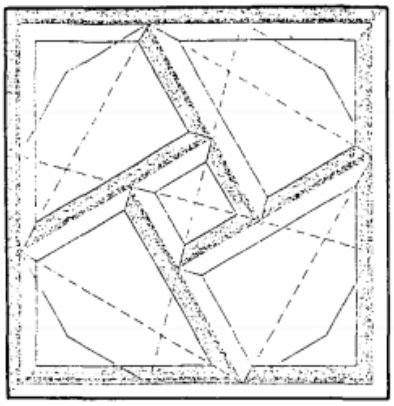


*Figure 16 An Islamic design based on Bhaskara's proof of the pythagoren theorem. The design as given by Critchlow.*

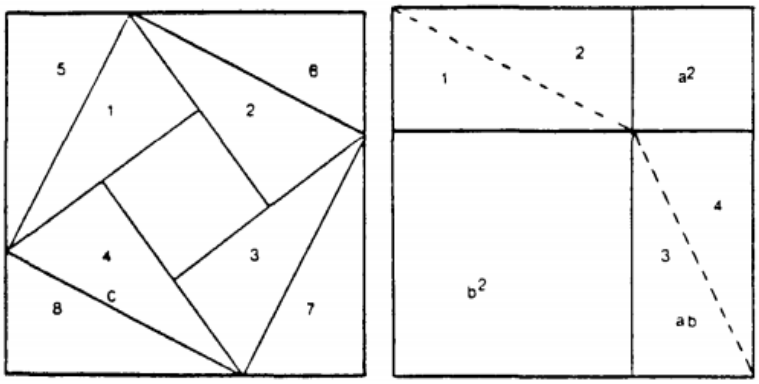



*Figure 17 An Islamic design based on Bhaskara's proof of the pythagoren theorem. Bhaskara's proof as given by.*

Figure 16 shows one of the panels that Chorbachi has studied. Figure 17 is islustrated If the kite shapes are divided into right triangles with sides a, b, c as in Figure 17, an ancient proof of the pythagorean theorem attributed to Bhaskara follows from the fact that the inner square has side b - a and the area of the square made up of the inner square and triangles 1, 2, 3, 4 is

$$c^2 = (b - a)^2 + 4\frac{ab}{2} = b^2 + a^2$$

Also, as Figure 17 shows, the very outer square has side a + b and illustrates the relation

$$(a + b)^2 = a^2 + b^2 + 4\frac{ab}{2}$$

Another object of Chorbachi's research is the tiling shown in Figure 18. The square is divided into four congruent sectors by two perpendicular lines and each sector is divided, in turn, into polygons of three kinds including a symmetric kite shape as shown in Figure 18 (a).

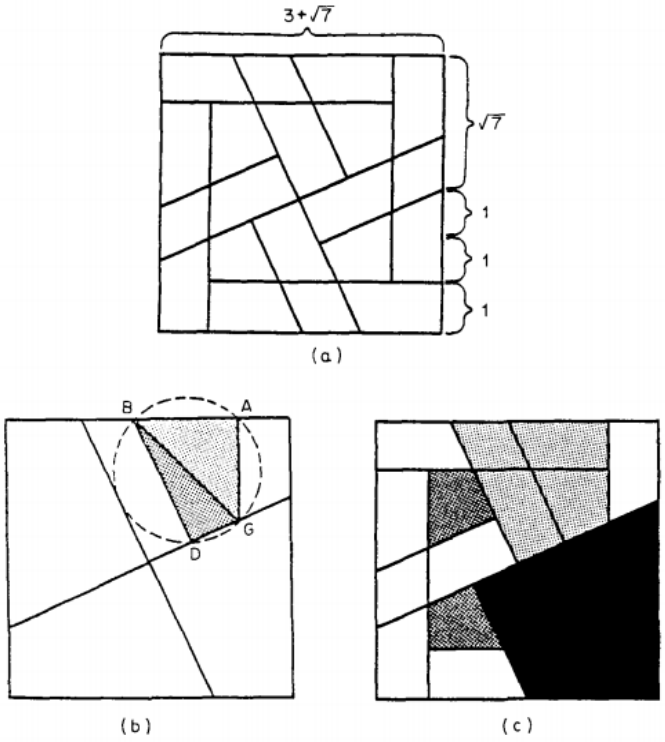



*Figure 18 Chorbachi's analysis of an Islamic pattern with fourfold symmetry*

The entire tiling has a fourfold symmetry, which means that a quarter turn about the center brings all the tiles of one sector onto the tiles of another. The key to understanding this tiling is an asymmetric quadrilateral ABDG with proportions 1:2:2:V7 inscribed in a circle as shown in Figure 18 (6). The sector of the square is obtained by adding two gnomons of unit widths to two sides of the quadrilateral as shown in Figure 18 (a). Figure 18 (c) shows that similar kites at three different scales can also be found within the tiling. In her article, Chorbachi has generated many of her own tilings based on this asymmetric quadrilateral and its geometric properties. Subdivide a square into four congruent sectors as in Figure 18 (a). It makes a good puzzle, for persons not aware of the origin of the sectors, to put the pieces together to re-form the square. It makes an even better puzzle to put the pieces together to form two squares such as in Figure 18 (a). This can

always be done. It is interesting that the same panel that Chorbachi sees in strictly geometric terms, Critchlow prefers to think of in spiritual terms. For example, the solid dodecagon and dotted square in Figure 17 (a) is Critchlow's doing. His interpretation is The coincidence of twelve and four suggests the zodiacal symbolism controlling or embracing the fourfold axial kite shapes which can be taken to symbolize the four seasons, the four elements, and the four qualities of hot and cold, moist and dry. (Chobachi, 1989)

CHAPTER 4

# ISLAMIC GEOMETRIC PATTERNS

# 4. COSMOLOGICAL APPROACH TO ISLAMIC GEOMETRIC PATTERNS

## 4.1. Heaven and Earth

The arts of the sacred have traditionally always been governed by the sacredness of the tools employed, particularly at the design stage. The compasses (or dividers) are the symbolic tools of the "Heavens"; the square and the straight edge are traditionally the symbol of the "Earthly". Hence the construction of all geometry is the integration between these two tools and their symbolic meaning'. (Critchlow 1983)

One of the interesting theories was proposed by Keith Critchlow. It is described in the book "*Islamic Patterns. An Analytical and Cosmological Approach*"

Professor Kaith Critchlow says that traditional Islamic cosmology, which has its authoritative roots in the revelation of the Quran, has been developed outwardly with the unfolding of Islamic science and philosophy. The teaching of all three major monotheistic religions confirms that the Creation was accomplished in six days. The subject is too extensive and it is inappropriate here to attempt tp enlarge on the meaning of this doctrine. However, it is appropriate to state it is an error of our own times to treat such matters as revelation on an exclusively literal plane.

This is not only damaging to the nature of revelation, as it prevents access to the ontological dimension, but amounts to blasphemy inasmuch as this world means a "hurt-doing" or a cutting off from unity. What we will do, however, is to recall the tradition of treating numbers as expressions of archetypes and observe the traditionally venerated quality of 1 + 2 + 3

(the divisors) equaling 6. The next peripheral set of intervals are twelve, which were established sequentially by first setting the 90° cross axis on the circle (by the lateral pair of arcs). These two archetypal number qualities are associated with the solar cycle, the four "turning" points of the year (equinoxes and solstices) and the twelve zodiacal mansions of fixed constellations that the sun passes through in a yearly cycle. Inside the twelve we see a set of seven points - the hexagon and its center. These are associated with the seven heavens as one of their symbolic forms. (Critchlow 1983)

The author describes meaning of the symbolism for Islamic architecture and art and particularly in geometry.
All of the symbolic elements in Islamic arts and every detail is connected with the sacred book of Muslims Quran. Even a small *surah* could be a result of big structures in Islam. It applies to main philosophy of Islam.

Another important book with useful reflections have written a scientist Seyyed Hossein Nasr. He use in his issue early writings of Ikhwan al-S'afa al Biruni and Ibn Sina. (Nasr, An Introduction to Islamic Cosmological Doctrines, 1993)

## 4.2. Geometric rules to create Islamic geometric patterns

When we geometrically analyze Islamic geometric patterns, we see that it is possible to create them with the help of the ruler, compass and pencil. Of course, it is possible to analyze them mathematically with the use of different formulas and difficult calculations. However, it is important to

understand the historical rules used by Islamic masters to create those patterns. To visualize how traditional craftsman worked to create patterns helps to recognize also the way how they was thinking.

Architects in the ancient word used a piece of rope and a piece of wood. The rope was tired to the fixed point in the center of a circle they wanted to draw and the wood was tired to another end of the rope. Master could make a perfect circle by walking round the fixed point. Obviously, the size of the pattern were determined by the size of the rope. The straight lines were been drawn also with the help of the rope by just holding both ends on two points. This method was good for big patterns but for the small ones they need to generate more accurate method. The accuracy is the most important thing to draw a geometric pattern.

The rope method was been replaced by the compass method. For the centuries, Islamic builders were used nonadjustable compass. Because it was very important the circles to be in equal sizes.

Construction of geometric patterns in İslamic art mostly consist of repetition of a single motif. So for the covering a big space the craftsman often used a square, hexagonal grid and created a pattern by connecting them with each other. Individual motif is repeated in each geometric unit of the grid. Sometimes they were connecting different units to cover a space, which does not have strait shape. Every geometric pattern starts with the creating of grid. We always start designing of patterns with a circle. Then we add secondary circles and connect them with straight lines. By this, we determine the basic shape of the patterns. Quantity sizes of circles and the way of their intersections' connection should be chosen depended on typology of the pattern. Typology means to which family of patterns our pattern belongs to. There are three common families of patterns. They are four-, five- and six-folded geometry. Most of the others could be created by multiplying number of circles. The family the pattern belongs to could be

identified by counting the star shape motif in the center of pattern. After the identifying, we draw a geometry inside the circle. Pentagons are the most difficult geometric shapes to create. They also have some complications on covering a surface. Squares and hexagons are much more easy to fill the surface. Sometimes in geometric patterns, we need combinations of the patterns.

As harmony and balance are important criteria in Islamic art. Sometimes it is difficult to represent those feelings just with the geometric lines. Islamic craftsmen used extra detail to make it work more. It could be a vegetal motive or a calligraphic writing.

As important elements of Islamic geometric art, Eric Broug shows in the book harmony and balance. A pattern that is made up entirely of straight lines is incomplete. It needs to add extra decorative elements to be completed, It is possible to bring out the symmetry and richness of a line pattern by adding vegetal motifs, such as flowers and leaves, for example, or color. (Bourg, 2008)

Some of the patterns create interlaced bigger pattern while connecting with each other. J. Burgoin shows in his book "Arabic Geometrical Pattern and Design" a big amount examples of the Islamic geometric patterns as shown, is developed by connection of regular triangles and some of them are interlaced. (BALTRUSAITIS, 1981)

A. K. Dewdney recently described a practical method of creating homemade Islamic tilings (1988). A set of intersecting and self-intersecting lines weave through the tilings, as shown in These lines are unrestricted except for the fact that each must originate and end at the boundary. If each crossing is alternately designated as either an overpass or an underpass, whenever one arrives at Tilings with Polygons. See Figure 19.

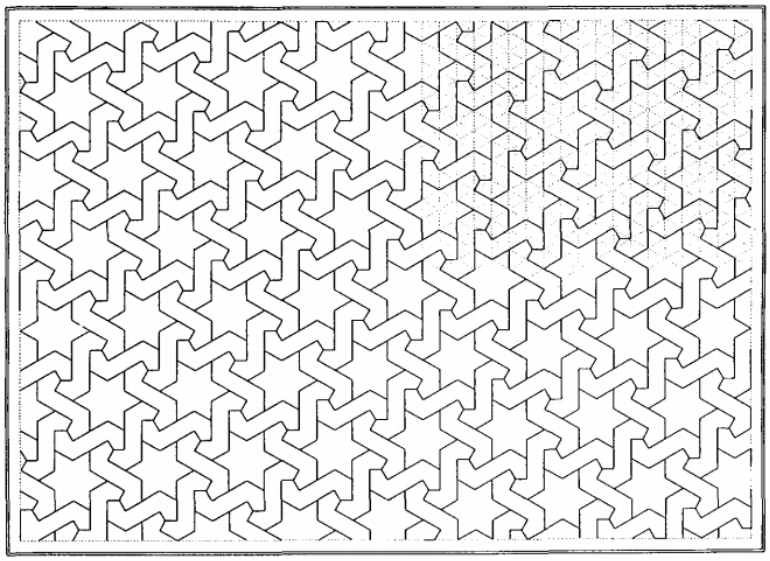


*Figure 19 An Islamic interlaced pattern by J. Bourgoin with underlying triangular grid.*

An Islamic pattern by J. Bourgoin with underlying triangular grid. A previously designated crossing, it has the required structure. Say one travels along the road bordered on the right by a region of some color. After the crossing, the color on the right changes. Thus one can say that an overpass always leads to, say, the color red (on the right) while an underpass leads to, say, blue. It follows that the road crossings must be assigned correctly after a cycle. (Jay Kappar)

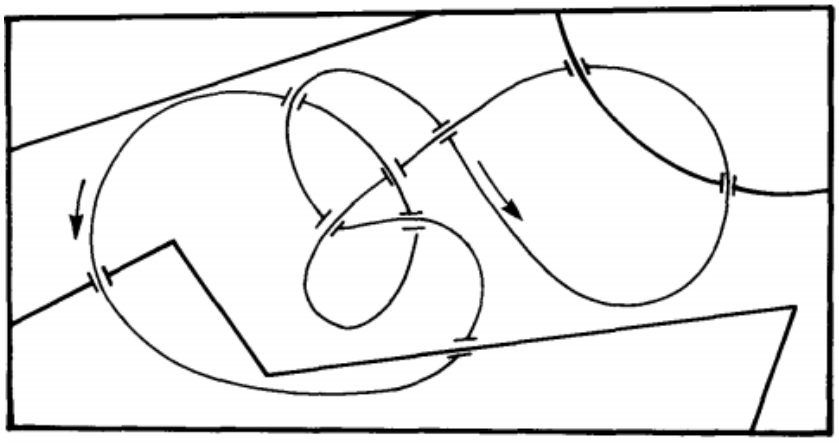


*Figure 20 Dewdney's "over-under" rule for the construction of Islamic*

## 4.3. Techniques of creating Islamic geometric patterns.

The first two techniques of decoration involved the medium of construction itself. In Anatolia, where the traditional medium of construction was stone, carved stone became the major medium for ornamentation. The technique is a very ancient one and does not require further elaboration, except on one specific point : in many instances the stone ornaments seem like have been applied to the surface of the wall rather than understood as a part of the fabric of the wall; it always seem artificial as an imitation of something else.

Much more original and different technique than the medieval Islamic use of stone is brick. It used for decorative and as well for the constructive purposes. It is also a good example of the decoration in two levels being connected like a puzzle. In later centuries, it was no longer the only technique of decoration, it was still a major one but the number of uses increased. The manner of creating a brick decoration had changed from linear zigzag patterns into curved dome decoration. It gives a texture to wall in some examples there were used bricks of different size to get a complicate pattern. In some examples, the effect of brick was artificially created in stucco.

The third remarkable technique of Islamic architectural decoration is stucco. Already in pre-Islamic times, whether in western Iran and Iraq stucco had been used to cover walls of palaces and temples, because the medium of construction – rubble in mortar or unbaked brick – was not very impressive and because of richness of surface decoration could create more important effect than barren walls. There are existed examples with stucco applied to the whole wall without major decoration.

The fourth important medium of decoration was more exist in Iranian territory. It consists of terra-cotta, basically, of ceramic fragments that were specially molded or formed to full some areas or to create a specific geometric pattern. This decoration type was more expressive than stucco and created a big contrast between decoration variations. It was already known in Parthian times in Central Asia.

CHAPTER 5

# ISLAMIC ART AND GEOMETRIC PATTERNS IN AZERBAIJAN

# 5. ISLAMIC ART AND GEOMETRIC PATTERNS IN AZERBAIJAN

*Figure 21 Azerbaijan in the map of the Europe. (Photo from the website wikimedia.com)*

In Azerbaijan, we will descry patterns from several regions. In general, we could divide it in for parts: Baku (capital of Azerbaijan) region, Nakhchivan region, Sheki region and Karabakh regions. We could notice totally different techniques of pattern creating in all of those regions. In Baku it is stone decoration, in Sheki and Karabakh it is window and other interior decorations and in Nakhchivan we see it in tombs decorations – stone and glazing methods. We will explore details of decoration in all of those regions in the paragraphs below.

## 5.1. Islamic Geometric Patterns in Sheki

Window where small pieces of glass were joined together with some kind of binder firstly was a result of technological restriction – craftsmen did not

know how to make a large piece of glass. Then the idea of making a decorated window out of colored pieces of glass painted with religious motifs and combined in way to form a picture popped up. Traditionally in stained glass windows of Catholic cathedrals in Europe strips of lead were used as binders.

The technique of stained glass production in Azerbaijan and Iran is different from European. Instead of lead, strips of wood are used. A strip of wood has channels where glass is inserted. Channels are normally used in traditional woodwork to connect up two pieces of wood together without using nails. The glass is placed inside channels and wooden strips are glued together. The width of a channel is equal to the glass thickness. In the past a 3mm-thick glass was used, but now, it is mostly of 5 mm thickness. A panel of wooden stained glass is solid and durable; it can stand a stroke of a man or a strong wind. The design of wooden stained glass based on geometry of a square or a triangle is widespread. Colors are very bright greens, reds, blues and yellows. Sometimes colorless glass is used.

In Azerbaijan, wooden stained glass is called 'shebeke'. Basically, 'shebeke' is a stone grill, but this term is also used for the wooden grill. In Azerbaijan, ancient town of Sheki is a center for shebeke production and restoration. Sheki Khan Palace built in 18th century is lavishly decorated with shebeke. Just in the Sheki Khan Palace have founded sixteen types of pattern. Along with geometric shapes, there are biomorphic rhomb-shaped motifs. The work is really intricate – some of the constructions are smaller than a female's hand.

Creating of "shebeke" was performed with connecting strips of wood and pieces of glass. All wood details have special recesses to connect it with glass. That wood pieces also are connecting to each other in that way without using of any glue, nails or any other connector. Different colored

or colorless small glass segments and wooden carcass were used to create geometric patterns.

In Iran wooden lattice windows was used as an architectural feature in all kinds of buildings. Magnificent Nasir al-Mulk Mosque in Shiraz built in the 19th century is famous all over the world for its stained glass decoration. Ali-Qapu palace and coffee house in Shesh Behesht garden, Madar-e-Shah medresse, old mosques in Isfahan – all of them have wooden grills on their windows. In Iran I noticed that the glass is placed behind the lattice. Marina Allin guesses that it is a result of lattice restoration and historically glass was placed inside wooden cells. (Allin, 2014)

The spiritual meaning of a stained glass lattice window most likely comes from a contrast between light and the absence of light. Light reveals shape and color; light makes things possible and represent Divine enlightenment. Practically the widespread use of wooden grills (as all other kinds of grills) in Islamic countries can be explained by the need for protection from a daytime heat. It is one of the features that traditional Islamic architecture has in order to help people to feel comfortable inside the building despite on the temperature outside. (Allin, 2014)

The "shebeke" decoration making skills are transferred from father to son. In 1977 in USSR magazine "Вокруг Света" (Vokrug Sveta) were printed an article about a craftsman in Sheki Ashraf Rasulov, who was a master in making "shebeke". Ashraf Rasulov explained how he creates that magic patterns. We can not be sure that the "shebeke" is done till the connection of all of the pieces together. He says that in a small detail of a door decorated with shebeke in the one square meter we could be found 14 000 details. Even a one millimeter mistake could destroy the whole pattern. Every detail should be made by hand: all of the wooden pieces and colorful glasses. See Figure 22. (Milovskiy, 1997)

*Figure 22 Photo of the craftsman Ashraf Rasulov, while making "shebeke". Sheki, Azerbaijan. 1977 (Photo by Ashraf Rasulov)*

Now the son of the craftsman Ashraf Rasulov – Tofik Rasulov continues his job. "Shebeke" is, thus, one of the special techniques inherent to Azerbaijani art.


*Figure 23 "Shebeke" window detail in Sheki Khan's palace, Sheki. (Photo by Alina M.)*

In Sheki, this method was employed in Sheki Khan Palace and some other monuments and used to create a type of stained-glass windows with Islamic geometric patterns. But the first examples of "shebeke" dates from the 12th-13th centuries. They were made in stone window decorations. Those decorations were used in palaces, simple living houses, mosques or "hamam"s.

The Sheki Khan's palace was built in 1762 during the Kajar dynasty rule period. It was built by Hussein khan, he was also known as a poet under is pen-name Mushdag. It was a summer residence of khan. There was other palaces from khan's period in Sheki. But this is the only one conserved till nowadays. The palace is a two-story brick masonry structure elongated on the north-south axis. It was covered with a wooden hipped roof with long eaves.

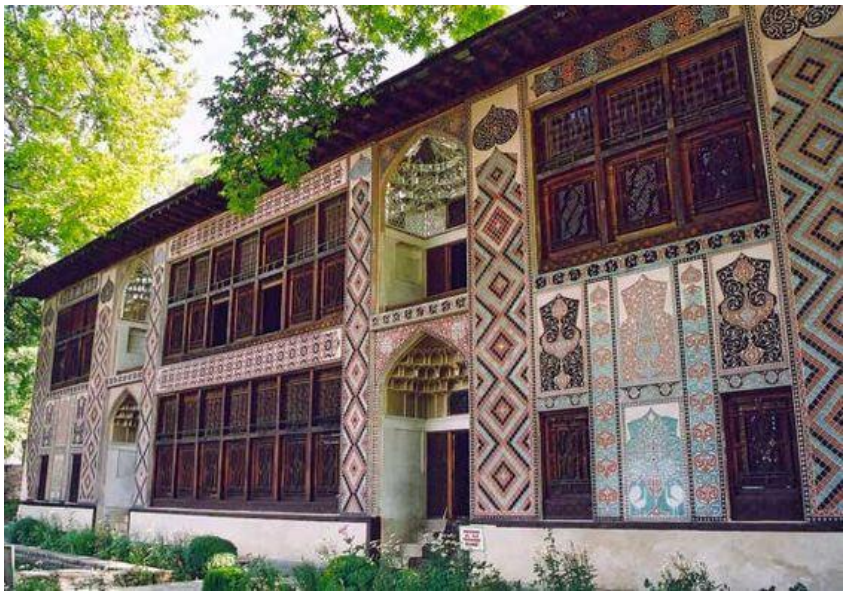


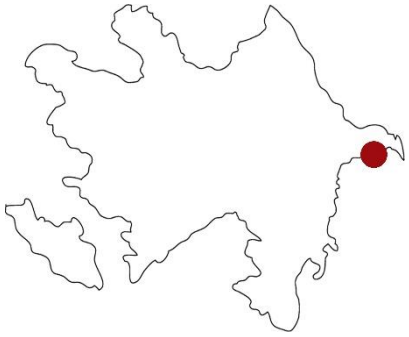
*Figure 24 Sheki Khan's Palce. XIIX century. Sheki, Azerbaijan (Photo by Niall Henderson)*

In the palace we see arabesques, miniature paintngs, mugarnas and geometric patterns. This makes interior decorations of the palace more active and dynamic.

Islamic geometric patterns there were used in the wall decorations, wood decorations and described below "shebeke". Among the patterns in the palace's "shebeke", we can notice six (6) folded, eight (8) folded and twelve (12) folded geometry.

*Figure 25 "Shebeke" window in Sheki Khan's palace, Sheki. (Photo by Alin M.)*

## 5.2. Baku Stone Geometric Patterns



Baku is the capital city of Azerbaijan, a land of fire, wind, stone, rich art tradition; a land where the "*evidence of Zoroastrian, Sasanian, Arabic, Persian, Shirvani, Ottoman, and Russian presence in cultural continuity*". (Reference to the website unesco.com)

Looking at the patterns in Baku, we could distinguish a different way of applying them; but for most of them, we mean, mainly stone decorations. In matter of fact, Baku could be named a "land of stone": accordingly, most of the buildings were made by using this material. In the Caucasus the habit and - might we say - , the tradition of stone carving amounts to 40

000 years ago, as witnessed by the famous Gobustan rock engravings. However, as we might expect, geometric patterns appear much later.

*Figure 26 Gobustan rock engravings. Baku, Azerbaijan. (Photo by Bruno Girin)*

Impact of Islamic geometry we meet again and again while walking the streets of the "Icheri Sheher". "Icheri Sheher" is the historic part of Baku city. It can be translated as "Inner City" and sometimes in English, it's called "Old City". The historical part of Baku is full of the Islamic elements in architecture: minarets, window, door elements and etc. all of them decorated with geometric patterns.

Despite the modern building surroundings, the Olds« city still keeps its uniqueness and its eastern-oriental flavor.

*Figure 27 Urban landscape from the Ischeri Sheher (Old City). He complex of Shirvanshahs palace. Baku, Azerbaijan (Photo by Aydan Aghabayli)*

One of the important architectural monuments inside the Old City in Baku is the Palace of the Shirvanshahs, built in the 15th century in the time of Shirvanshahs reign, from the moment where the capital was transferred to Baku in result of the huge earthquake that victimized Shamaha .

The location of this palace on the Baku hill is one of clear dominance and we can see it from afar. Among the medieval structures of Baku, this complex stands out for its architecture, massiveness and decorative features.

It is a large and ordained gathering of several buildings consisting on the main building, *divankhana*, the mausoleum, the palace mosque and the palace bathhouse. We can observe there a big amount of Islamic geometric patterns examples.

The main building was built in 1411 by the efforts of Shirvanshah Sheykh Ibrahim I.

The mausoleum, palace and the mosque architects used the same material, and the masonry is completely regular. Through the inscription desk with the construction, dates were found only on the mausoleum (1435 – 1436) and on the minaret of the mosque, (1441 – 1442), archeologists and historians could just guess that the mausoleum, the mosque and the palace were built in near dates. But it could be that the palace was built before, in the first decades of the XV century.

For the building itself, it was constructed by phases, the first phase consisting of the central part, followed by the surrounded western part.

Big stone surfaces are diluted by the masonry layers alteration that differ by color, width, facture and as well by the kind of "shebeke" – stone lattices in the small light openings.

*Divankhana* is an eight-edged rotunda – a pavilion with a small courtyard inside made exclusively in stone. The western entrance portal of the rotunda is decorated with arabesques, Arabic inscriptions and geometric patterns. They are inscribed in octagons that are also connected with each other.

Ornaments also cover tympanum and windowpanes under the openings. The portal leads into a passage connecting the hall with a podium placed in the crypt and the service facilities located one above the other.

On the southern courtyard near the palace, there is a building of the Mausoleum, where the court scholar Halilullah I Seid Yahya Bakuvi was buried. The internal decoration of the mausoleum consists of an underground crypt where the headstone of Bakuvi and camera is located. The small octagonal mausoleum volume turns into a drum covered with an outlined dome. On the both sides of the mausoleum, there are three small windows carved in solid slabs of limestone, representing a crosscutting stone lattice consisting of multipath stars. The arched doorway located in

the northern part of the mausoleum was used as a connection with an older mosque.

*Figure 28Shirvanshahs palace decorative stone "shebeke" window elements. Baku, Azerbaijan. (Photo by Aydan Aghabayli)*

The decoration of Shirvanshahs' palace dates from the 15th and 16th century. Motifs are biomorphic patterns, showing exquisite Rumi-style carving, « vine leaves, geometry and calligraphy, all carved 3-5 cm deep. *Muqarnas* of portals are also carved. "*The Complex of Shirvanshahs' Palace is made out of well-hewn local limestone, called "badamdar". Limestone being milky white, after grinding acquires golden tint*". (Alin, 2013)

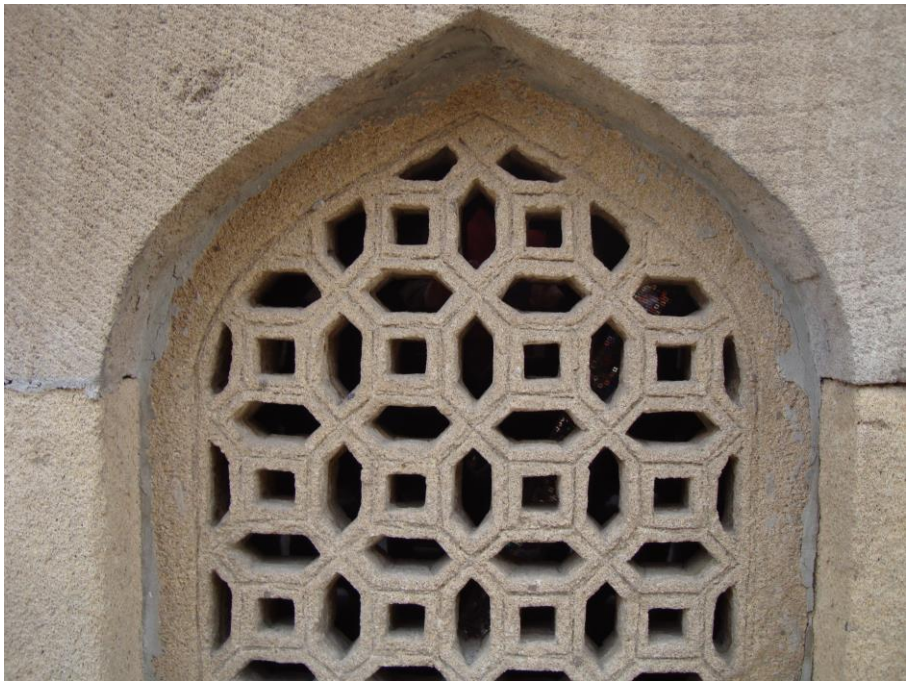


*Figure 29 Decorative stone "shebeke" window element. Baku, Azerbaijan (Photo by Aydan Ahabayli)*

Hexagonal medallions over the arches of Mausoleum of Farrukh Yassar (octagonal building on the site of the palace complex, also called *Divankhane*) show stone carved calligraphy. Inscriptions are written in very ancient Kufic Arabic script. On the left, the inscriptions carved inside the medallion are framed by six geometrical patterns in a rhomboid shape. Two of them run: "*There is no deity but Allah*". The other two read: "*Prophet Mohammed is the messenger of Allah*". The rest of the rhombs run: "*Imam Ali is close to Allah*". The hexagonal medallion on the right contains twelve small rhombs. Six of them run: "*Allah is the single one*", the other six bear the name "*Mohammed*"" .

Stone decoration of Baku architecture is superb. It is where the great level of craftsmanship and elegance of artistic expression is shown, the ancient craft of stone carving serving Islamic art.

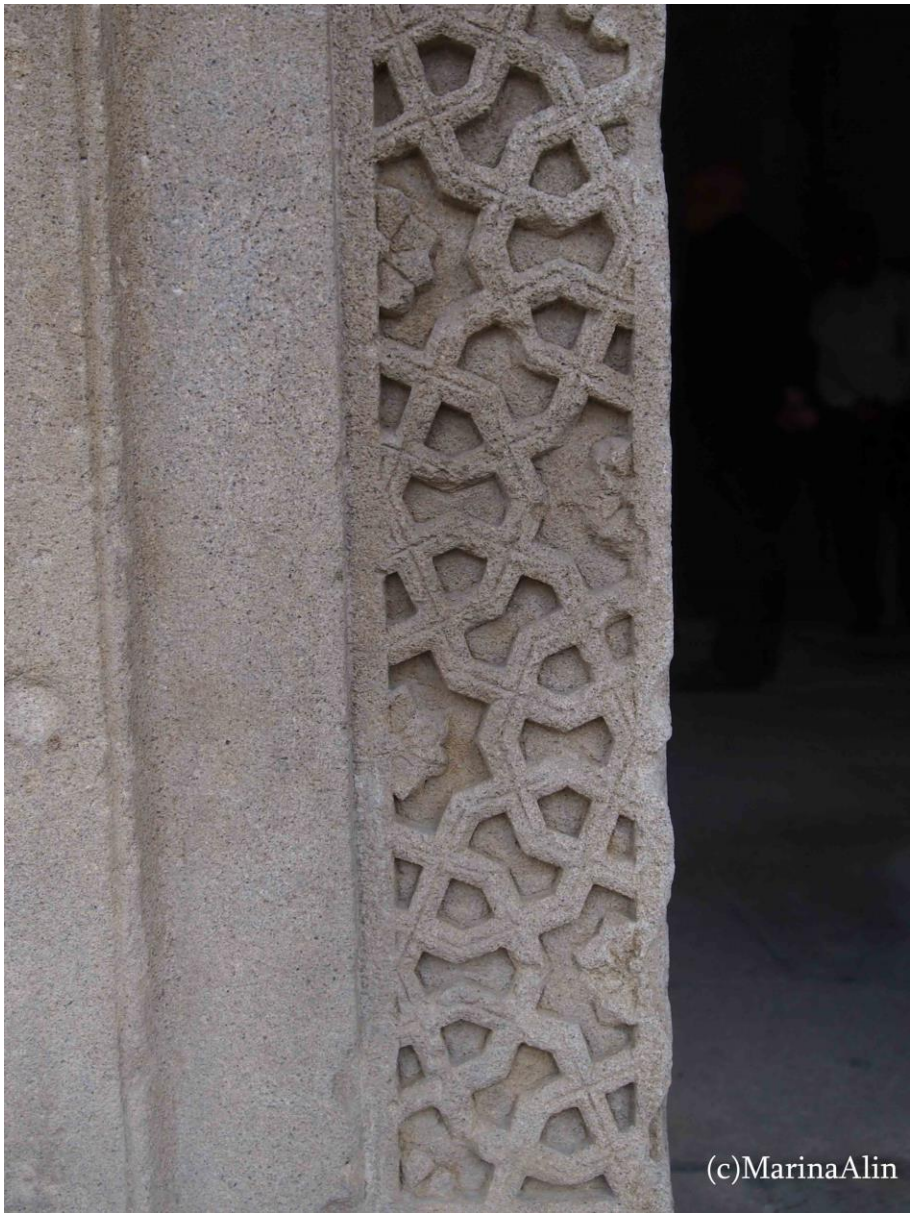



*Figure 30 Geometric pattern in Divankhane. Icheri Sheher. Baku, Azerbaijan.. (Photo by Maria Alin)*

Apart from the decorations of Shirvanshahs' palace, there are several old minarets around the Icherisheher showing carvings based on geometry patterns and calligraphy. Other stone carved pieces are gravestones and gravestone panels with a variety of motifs. They are conserved in Icherisheher of Baku.

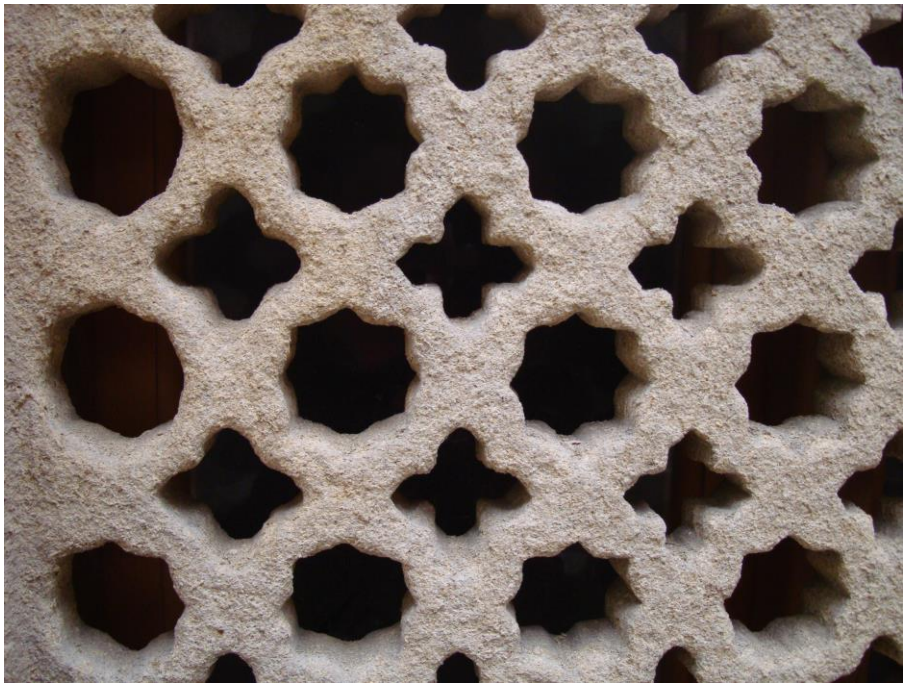


*Figure 31 Window element of the mosque of Israphil Agha in Icheri Sheher. Baku, Azerbaijan (Photo by Aydan Aghabayli)*

*Figure 32 Examples of the Islamic Geometric pattern on stone decoration of the top of the minaret of the mosque. Baku, Azerbaijan (Photo by Aydan Aghabayli)*

Those traditional types of Islamic geometric patterns decorations are used until nowadays in the modern architecture in Baku. Especially restoration

works and in the new building in the Old city this method is used as an imitation of the old architectural style.

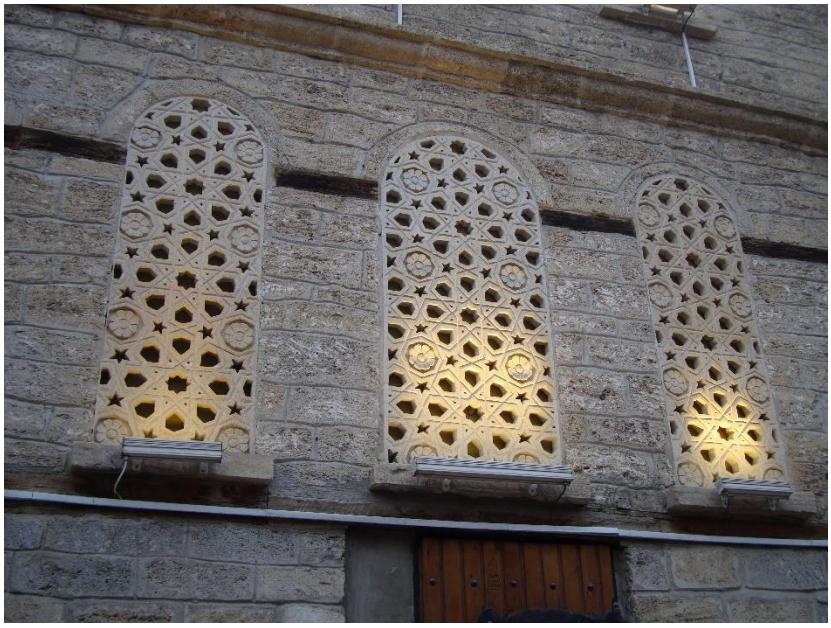


*Figure 33 Modern interpretation of Islamic Geometric patterns. And invorlving them to the new building in stone "shebeke" window detail. Baku, Azerbaijan. (Photo by Aydan Aghabayli)*

*Figure 34 Modern interpretation of Islamic Geometric patterns. And invorlving them to the new building in window decoration detail. Baku, Azerbaijan. (Photo by Aydan Aghabayli)*

## 5.3. Islamic geometric patterns in Nakhchivan

Wide variety typifies examples of patterns in monuments of Nakhchivan. They are observed mostly on mausoleums' decorations.

When we study the origins of architectural decorations and ornaments, we could see that arts are an integral part of the society. The Ottoman Empire period left an important mark on the arts and the architecture in Nakhchivan region. Turkish art originates entirely on nature elements. Every detail and every line of that art is life and action. Decorative elements in the designs are quite expressive in that matter. All of the figures have some vitality, as they appeared with the influence of a totemic thought. Thus, forms taken from nature were been transformed to patterns and its vitally lines braked, delayed and become flat.

We must stress, however, that Nakhchivan architecture style is different from the others that existed in Azerbaijan. It uses brick as construction material and applies colored glazed tiles (especially turquoise) for geometric pattern decoration.

The most important examples are within the class of mausoleum architecture. We could recognize the architectural style of the period where a large amount of Islamic geometric patterns still stand today as a proof on the huge variety of decorative solutions.

Patterns are glazed, carved in stone or brick, created with bricks laid as a pattern. As well as ways of application the patterns itself are also various. In mathematical approach, we could differ their models with 4-, 6-, 8-, 10- and 12-folded geometry, fig. 8, fig. 9. Their construction period of them is dated to the XII century, which is date of rule of the Seljuks empire. The most important buildings of the 12$^{th}$ century were designed and directed constructed by famous Azerbaijani architect Ajami ibn Abubakr Nakhchivani.

One of those projects of Ajami, is Yusif ibn Kuseyir Mausoleum (Mausoleum of Yusif son of the Kuseyir) located in Nakchivan city (1186 – 1187). It attracts attention with its simple geometric form and nice harmonic structure. The mausoleum itself has an eight-pointed in plan and have a strong constructive solution. A pyramidal tent covers the building. Decoration of the mausoleum was made from bricks, terracotta, and stucco, and uses simple geometric forms.

Figure 35 *Yusuf ibn Kuseir mausoleum in Nakichivan. General view. XII century. (Photo from the https://en.wikipedia.org/wiki/Yusif_ibn_Kuseyir_Mausoleum)*

Niches of the building are covered with brick accumulated geometric patterns. Every pattern has an independent motive, marked of triangular six edged polygon in form of rhombus facing blocks attached to the fundamental laying. Above the geometric patterns, we see a rounded band with arabesques with inscriptions from Quran. Only the northern part of the mausoleum have different composition. The upper part of the portal is decorated with an epigraph. All of the epigraphs of the mausoleum are made of well-burnt bricks.

Qadir Aliyev in his book "Harmony in the Works of the Architect Ajami" have descried patterns in that mausoleum.

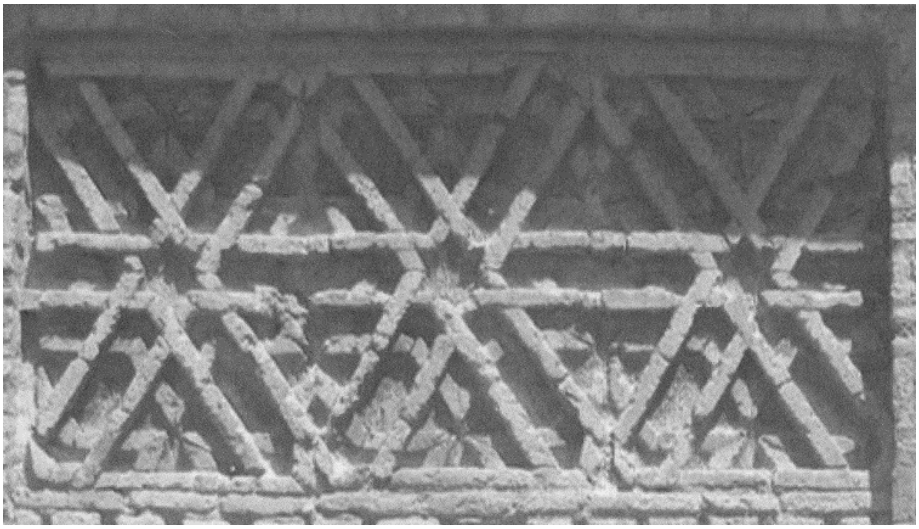


Figure 36 *Photo of the pattern on door decoration of Yusif ibn Kuseyir Mausoleum.*
*(Photo from the book "Harmony in the Works of the Architect Ajami")*

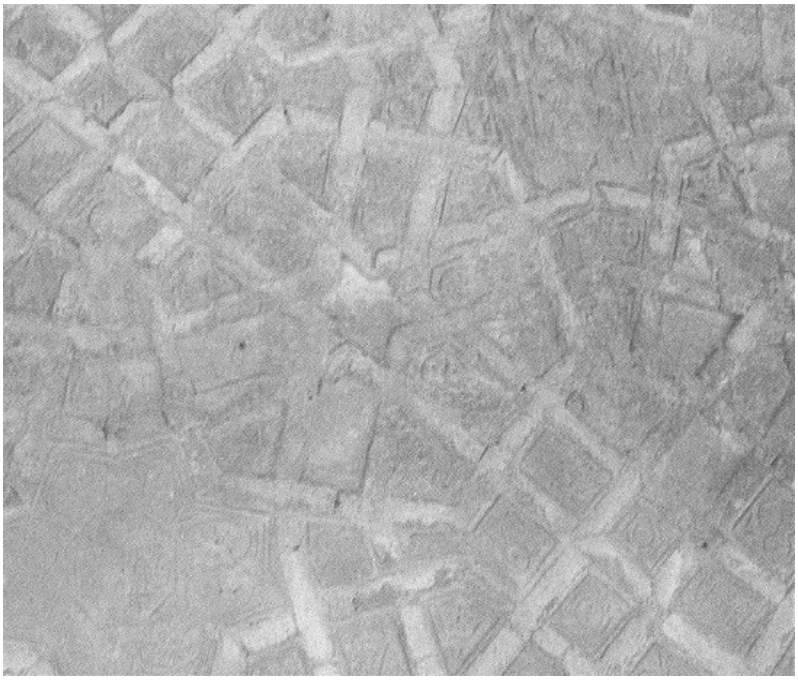


Figure 37 *Photo of the pattern on door decoration of Yusif ibn Kuseyir Mausoleum. (Photo from the book "Harmony in the Works of the Architect Ajami")*

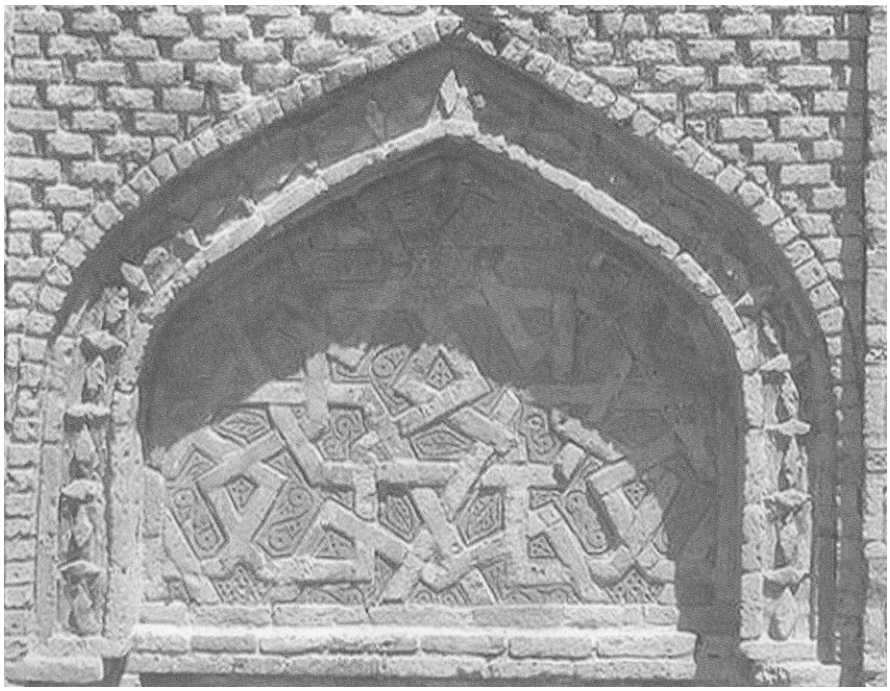


Figure 38 Photo of the pattern on door decoration of Yusif ibn Kuseyir Mausoleum. (Photo from the book "Harmony in the Works of the Architect Ajami")

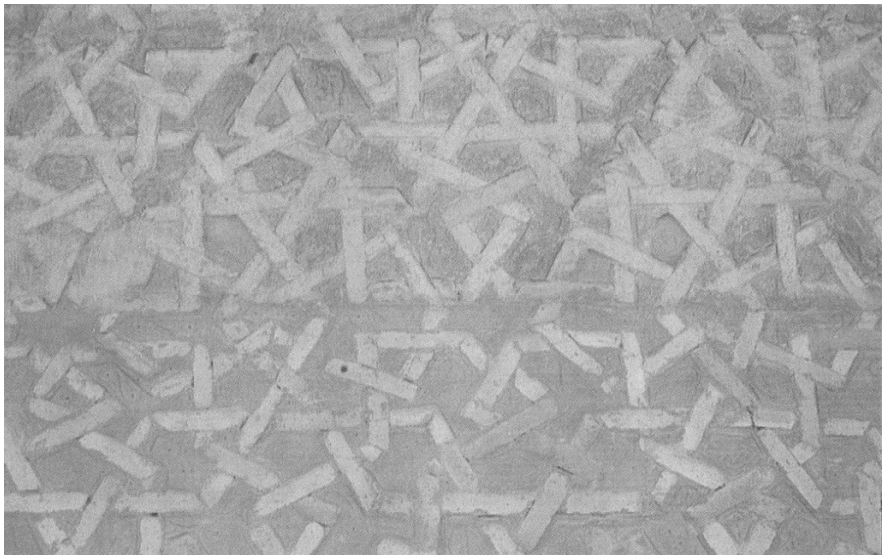


Figure 39 *Photo of the pattern on door decoration of Yusif ibn Kuseyir Mausoleum. (Photo from the book "Harmony in the Works of the Architect Ajami")*

The second important building – designed by Ajami as well - is the Momine Khatun Mausoleum. It was built 26 years later than previous mausoleum. This mausoleum uses much more detailed premisses but the main principles of architecture attitudes stays the same. We could call it a monument that represents Nakchivan architectural style of Seljuc Empire reign period. It is obvious how the architect improve his art style with the growing complexity of its multiply decorative designs and for a far greater articulation of surfaces of the walls. (Əliyev, 2007)

At Juga in some distance from Nakhchivan city is located another mausoleum, probably from the 13th century, whose squatness recalls contemporary Anatolian buildings, but whose decoration of complex geometric designs is quite Iranian in style.

Figure 40 *Momine Khatun Mausoleum. (Photo by Javid Seyidov)*

It is clear that mausoleums in Azerbaijan create a distinctive group, both related to, and separated from mausoleums of Anotolia and Iran. Almost all of them have preserved the name of the architects. (əliyev, 2007)

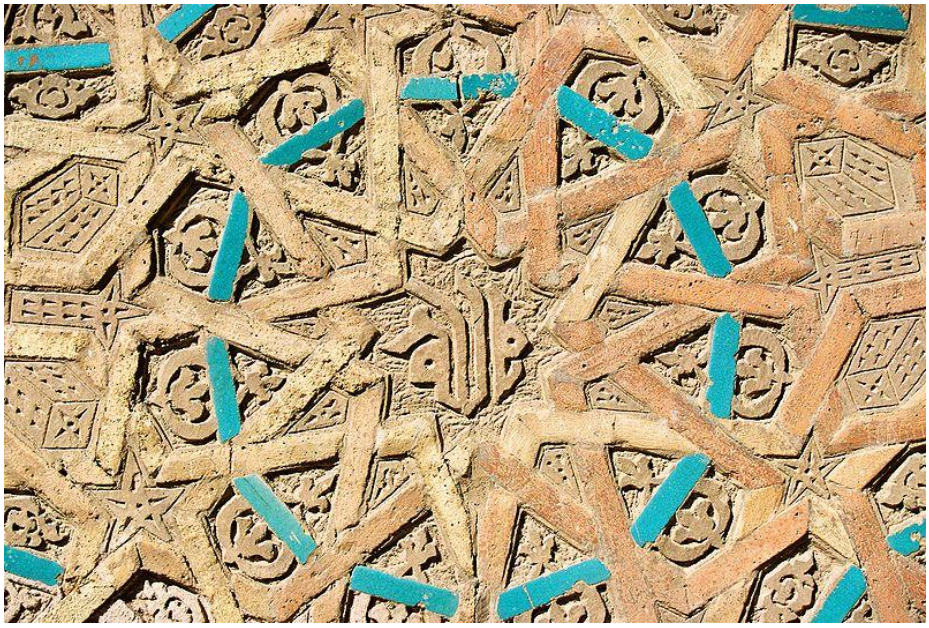


*Figure 41 Fragment of the Islamic geometric pattern in exterior decoration of Momine Khatun Mausoleum. Nakhchivan, Azerbaijan*

## 5.4. Karabakh Geometric Patterns

It is important to notice one more part of territory of Azerbaijan – Karabakh. Kharabakh is a territory of Azerbaijan occupied and controlled by Armenia. During the occupation in the 90's by Armenian military units damaged a big amount of valuable monuments. Several Islamic architectural monuments have been damaged. The fact is that the destruction still is – and will continue to be- an obstacle to study those architectural monuments, since even general information and old documentation about those monuments is difficult to obtain.

### 5.4.1. Shusha

Shusha is the one of the most important cities in Nakhorno-Karabakh region. The main feature of Azerbaijan's urban development in the 18th century was forming khanate capitals determined by the country's socio-

political regime. Having obtained relative political and economic independence in the dismembered country, khans first of all tried to build capitals with strong defense, stable economy and beautiful urban environment. Though most of the capitals were old, there were new cities, their emergence due to historical and natural factors.

Among newly emerging khanate capitals, Shusha City, the Karabakh Khanate's capital, is distinguishable for the unusual nature and strategic advantage of its position.

The founder of the Karabakh Khanate took up building a reliable residence for himself after gaining independence in 1747. Previously constructed Bayat and Shahbulag Castles not fully meeting the time's defense standards, Panahali Khan first of all summoned the State Board to decide for constructing a new Castle. The Shusha summer pasture was chosen for the location of the new residence place. The history of Shusha Castle's foundation has not been completely clarified yet. Karabakh historians stress the city-castle being constructed after Bayat (1748) and Shahbulag (1752), yet the date they indicate (1170 Hijra/1756-57 AD) is not accepted due to discrepancies from outer historical sources. To clarify the issue, information found out in the 19th century's Russian sources by Elturan Avalov is very valuable. It is stated that Shusha's foundation by Panahali Khan in 1167 Hijra (1753 AD) was mentioned in an inscription placed on one of the Juma Mosque's walls. This stone inscription had been taken off during the following reconstruction. According to this lost inscription, Shusha Castle was founded in 1753.

Among Azerbaijan's khanate capitals of the age, Shusha was the best to fit a "city-castle". "Rising over an unreachable rock" (G. Keppel), Shusha's entire composition resembles city-castles depicted in ancient Midian wall drawings (9th century BC). Having stood a number of strong attacks and sieges since

its construction, Shusha was Karabakh's main Castle known as that from the capital letter among people.

Similarly to other medieval cities of Azerbaijan, Shusha's neighborhoods consisted of private houses with patios. Most buildings of Shusha were two-floor and quarry-stone. With stained-glass windows (shebeke) of their big verandas and multicolored decorations, Shusha's traditional houses did not differ from those of other Azerbaijan regions. Several valuable specimens of those houses have survived. Such houses as Khans' and Beys' Palace were especially distinguished for the splendid artistry of their architectural concept even in comparison to the Haji Gulu's Estate, houses of IMatavan, Ughurlu Bey, Asad Bey, the Mehmandarovs' and others. However, most of them have not survived.

Besides houses, each Shusha neighborhood was formed by a local socio-religious center. Such centers consisted of buildings around a neighborhood square, a mosque, madrasa, bath, shop and spring. Though the exterior of Shusha's rectangular-plan neighborhood mosques (Julfalar, Chukhur, Haji Yusifli etc.) is sim ilarto houses, the interior completely met standards of religious architecture. Neighborhood mosques (Chol Gala, Taza, Saatli, and Mamayi) with athree-nave prayer hall are notable for the special perfection of their plan and location. While most of neighborhood mosques have small booths for muezzins on their roofs, the Saatii Mosque has a brick minaret with patterned decoration. The Yukhari Govhar Aga Mosque, built by the 19th century's great architect, Kerbalayi Sefi Khan Garabakhi*, in 1883, isthe most monumental among Shusha's. This site, built in place of Ibrahim Khan's mosque (1768) by his daughter, Govhar Aga*, is Shusha's Boyuk Juma Mosque (Great Cathedral). The prayer hall of the mosque is three-nave, almost a square (190-185 meters). From the northern part, a three-beam veranda makes the Juma Mosque a rectangle (26.5 x 21.5 meters).

In the veranda corners, there are two minarets and stairs to the balconies (women's premise) of the prayer hall. The hall is divided into naves by 6 stone columns. While the side sections are under pointed coverage, the two square parts are domed. The interior is lighted through double windows. The two minarets beside the facade make up a deəp veranda. The entire building from stone, the minarets are of bricks. The cylindric bodies of the minarets have horizontal belts, and each section is laid on by different brick patterns. This technique, applied by the architect Kerbalayi Sefi Khan Garabakhi for all big religious structures he built, played an important role in the architectural image of the 19th century's Garabakh mosques. The Juma is dominant on the Square, Shusha's main one.

150 meters North-East from the Square, a formed architectural complex is situated around the Aghdam Govhar Aga Mosque including a madrasa, shops and houses. This mosque, built by Kerbalayi Sefi Khan in 1868-1870, looks likethe juma mosques of Aghdam and Shusha in terms of general plan-and-location specifics. However, the two minarets of the Ashaghi Govhar Aga are placed not in the front facade, but in the corners of the rear one. All Shusha neighborhood mosques, one could say, being built with Kerbalayi Sefi Khan's participation, a common architectural method is felt in them.

Shusha actively participated in the 18th-19th centuries' international trade. Commercial operations it had with Eastern and Western countries determined the emergence of a developed commercial center in the city's composition.

The entire city's core, the Square is that of the main trade complex as well. Shusha's three commercial streets start from it: Rasta Bazar to the North, Ashaghi Bazar to the East, and Sheytan Bazar to the South.

Shusha's main religious buildings, caravanserais and trade squares were located in those streets, shops beside. Founded by the Garabakh Khan Panahali 250 years ago in place of an ancient settlement, Shusha is a rarity of Azerbaijan medieval urban development, a live encyclopedia of Garabakh architecture. In 1988, Shusha City was given the status of the State Historical and Architectural Reserve of the Republic of Azerbaijan. (Giyasi, Bayramov, & Afandiyev, 2008)

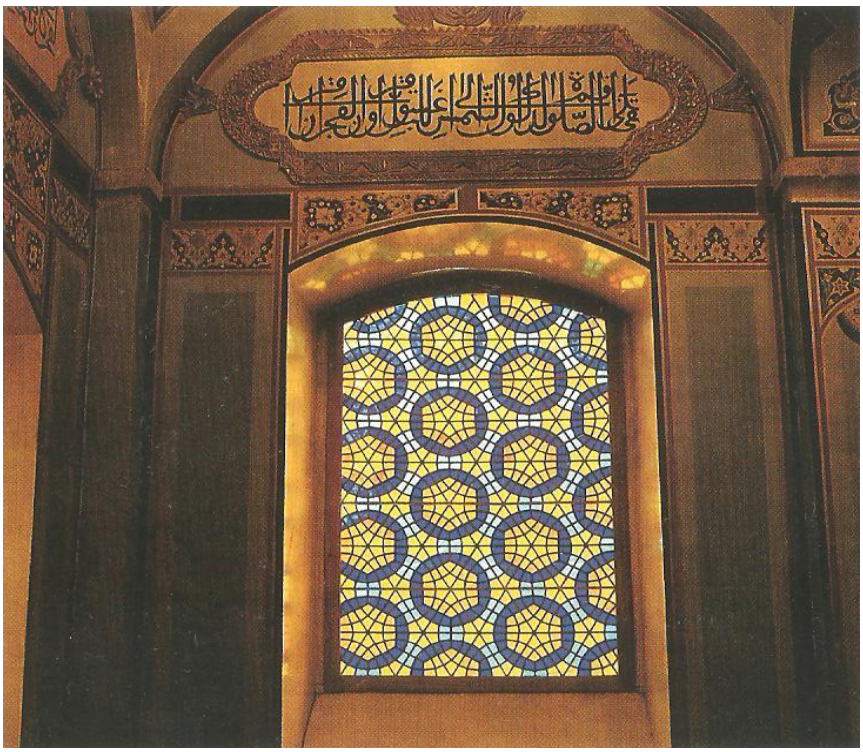


Figure 42 *Saatli Mosque. Stained-glass window (shebeke). 18th century.*
*(Photo from the book "Garabakh - the eternal memory of Azerbaijan heritage")*

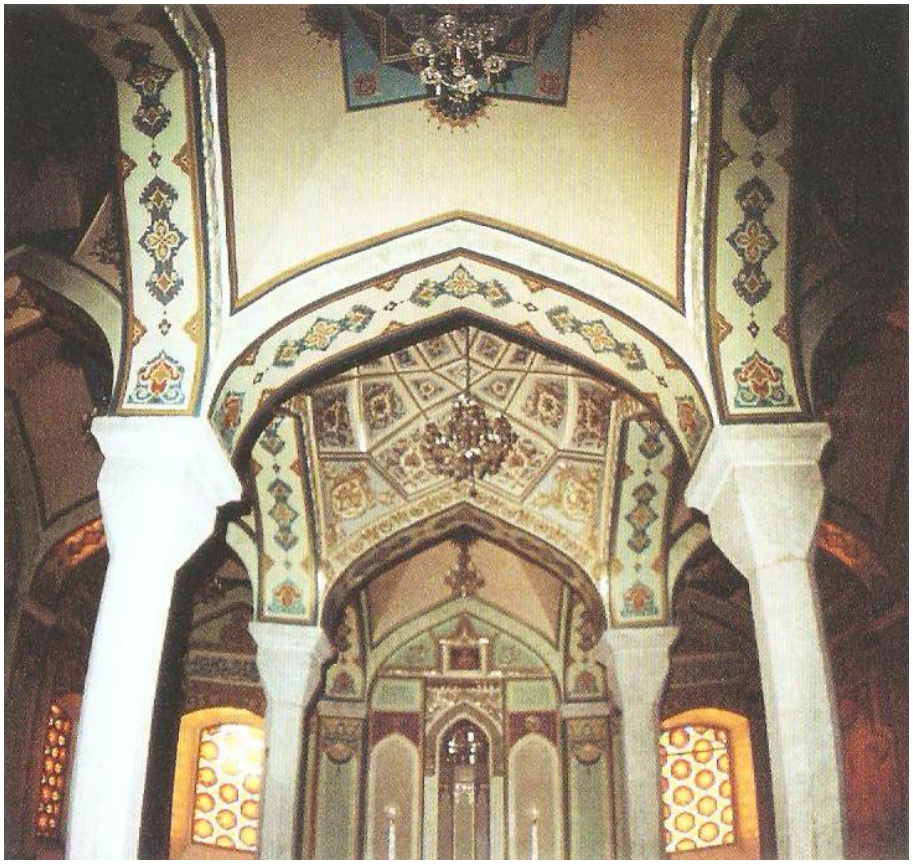


Figure 43 *Saatli Mosque. Ceiling. 18th centur.*

*(Photo from the book "Garabakh - the eternal memory of Azerbaijan heritage")*

### 5.4.2. Aghdam

A valuable example of the Elkhanids' memorial architecture has survived in the district's Khachin Turbatli Village. A construction inscription above the front door of this site, popularly called "Sari Musa' Tomb", says " Master Shahbenzeri has built this tomb for the deceased Gutlu Khaja Musa Oglu, honeeds Allah's mercy". By this inscription, the tomb was finished on July 15th, 1314. It seems the tomb of the person, who was an influential figure of Azerbaijan's historical Khachin District, has determined the village's name ("Khachin + Turbet ( "tomb" ) + li ( a postfix )).

*Figure 44 The tomb of Gutlu Haja, popularly called "Sari Musa Tomb". Aghdam, Karabakh, Azerbaijan. (Photo from the book "Garabakh – the eternal memory of Azerbaijan heritage")*

A valuable example of tower-shaped tombs, the building's exterior contains of three-type low benches, a 12-side prismatic body and tent-like pyramidal dome. The body and benches are covered with good hewn

yellowish lime. The nine sides of the body have beams, while the northern, eastern and western sides have door and window frames arranged. Because of a large size and artistic concept, the northern frame is the main entry.

The top pointed segments of all niches, doors and windows in the tomb body have been processed through subtle stalactite compositions. Fine pilasters, to an extent seeming too small for stone architecture, were constructed in the body corner. Besides stalactites, facade surfaces are decorated with stone carvings and different symbolic animals (bulls, lions, deer, rabbits, etc.)

For live appearance on the natural stone, these pictures were dark-red-painted. The tomb has dynamic volume composition, which is typical for Azerbaijan tower-shaped tombs. However, the original features of Aran, including Karabakh, architecture found themselves in both the construction technique and artistic decisions of this site.

The tomb has a double constitution of the under vault and over ground chamber. The both of them are cruciform. Unlike the severe and simple looking vault, the interior of the top chamber is extremely luxurious. The square central part of the interior covering and beam sections joining it from the North and South have complicated and subtle stalactites. The south wall, facing the front door, is like a richly decorated *mehrab*. Lie in the façade, some elements of the *mehrab* decoration are dark-red-painted.

The high level of the artistic and constructive solutions of the tomb interior demonstrate the customer's power and resources and the architect Ustad ("*Master*") Shahbenzeri's great professional skills and experience. A perfect piece of architecture, the tomb of Gutlu Haja with dignity demonstrates the time's philosophic and artistic tendencies.

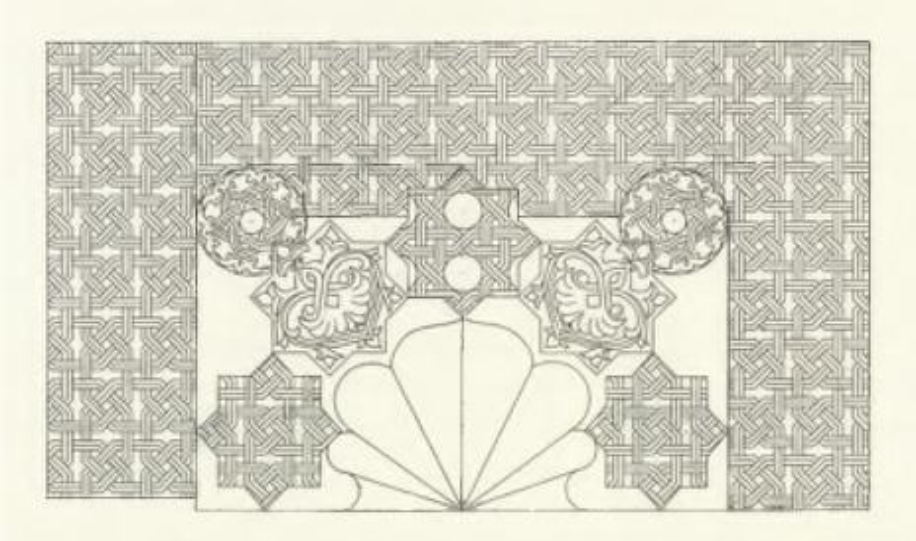


*Figure 45 Patterns from the tomb of Gutlu Haja, popularly called "Sari Musa Tomb". Aghdam, Karabakh, Azerbaijan. (Photo from the book "Garabakh - the eternal memory of Azerbaijan heritage")*

CHAPTER 6

# PORTUGAL AND ISLAM

# 6. PORTUGAL AND ISLAM

*Figure 46 Portugal in the map of the Europe. (Photo from the website wikimedia.com)*

## 6.1. Historical review

The actual Portuguese territory was under the rule of Muslims during more than five centuries, between the eighth-century until the thirteenth-century. During this period, Christian, Jews, and Muslims lived side by side and had freedom of cult. Consequently, this cross-cultural relationship fostered and enhanced the flourishing of new ideas and concepts. Being deeply rooted in the essence of the populations of these regions, lasting until the present.

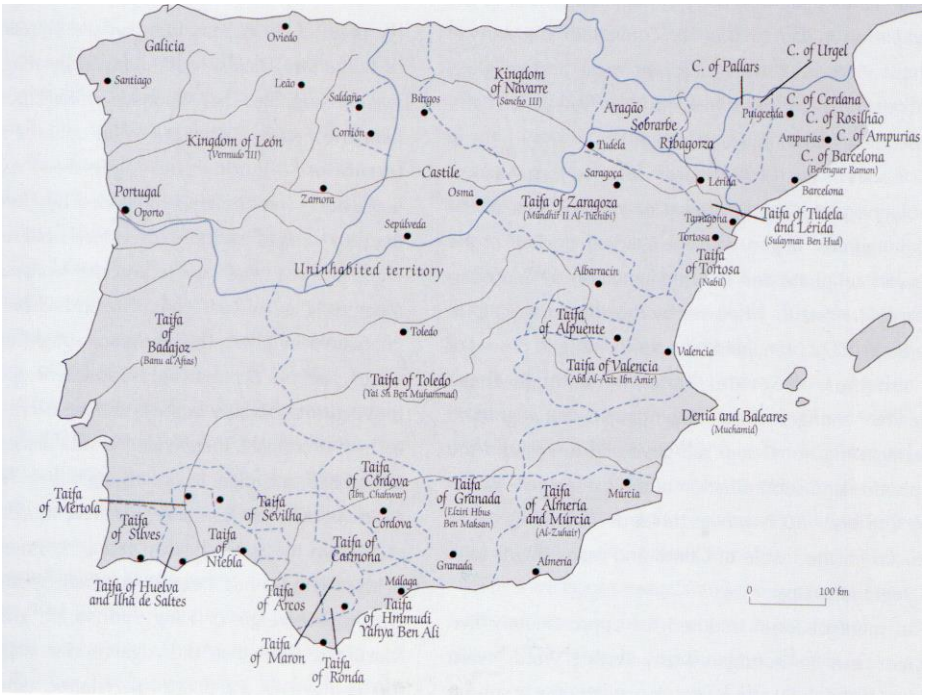



*Figure 47 Islamiic taifa kingdoms in Iberia (10-11th cent.)*

Albeit in Portugal we can't find the same richness of islamic heritage found in neighbouring Spain, there are still a few examples of architecture and decorative implements that are strictly related with the muslim origin and presence in this Western part of the Iberian Peninsula, overall known to the arabs as *Gharb Al'Andalus*, wich is still the name held by a Portuguese southern province (and realm, till the later days of the 18th century) and one of the most famous summer vacation places in Europe: the *Algarve*. But not only here, but also in other southern regions of Portugal we can find traces of the Islamic inheritance, manly in Alentejo and also in Estremadura.

There are even traces of mozarabic christian faith: the *mozarabes* (*must'arab*: "*those who became arabs*"), as we already guessed, were christians under arab dominion, paying a fee to keep its religion, but using

arabic language and dressing as arabs. So much so that in the Gharb, the principal christian religious pilgrimage center was the mozarabic sanctuary of what we might translate as "the Crow Church" or Igreja do Corvo (*khaniçat al-ghurab*) in the westernmost part of Sagres peninsula (the arab *Chakrach*') where the relics of St. Vincent were kept, later to be taken to Lisbon in the 12th century…

This is quite an original circumstance that we witness in Portugal –but also in Spain. Mozarabic art (8th-11th century) was influenced by the centers of political power in Iberia such as Toledo, Cordoba and Seville under the realms of the emirates (756-929) and the caliphate (929-1031). Nevertheless, on the other hand, one could find, also, entire communities of *muladis*, that is to say, Christians converted to the Islam.

However, the art byproducts of these communities were not intimately related with geometrical patterns: the mozarabic and early Islamic art in Portugal was mainly influenced by byzantine and Persian motifs of rugs, ivory objects and the like that were imported or adopted as models at the time by christian communities, as well as by the  this rather large Islamic communities that we find strongly imbedded in Portuguese territory till the conquest and the crusades led by the northernmost christians from the 11th century onwards.

*Figure 48 Ivory perfume box: Cordoba origin (Braga Cathedral, 10th cent.); detail.*

*Figure 49 Mozarabic stones from Chelas and from Lisbon Cathedral (Sassanid motifs)*

We should have In mind that nonetheless the scarcity of Islamic remains, destroyed by the crusaders and christian colinizers, it was during the Almoravid dinasty (1102-1142) and the Almohad dynasty (1151-1228) that the more enduring objects and elements of architecture remained.

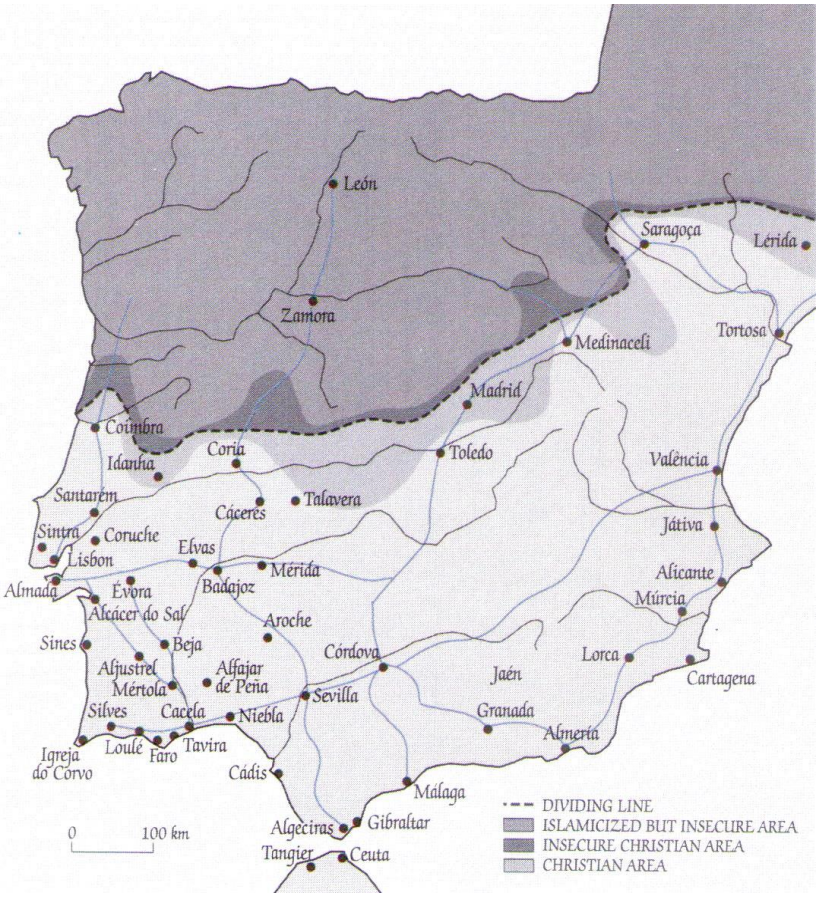



*Figure 50 Islamic Iberia (12-13th cent.)*

## 6.2. The astonishing "Cava de Viriato" (Viseu)

A monument remained from the early 9th centrury. And this is a surprising translation into an earthwork of the geometric patterns seen throughout the Islamic world: the *Cava of Viriato*, in Viseu.

It's a huge structure with a surrounding earthwork with an exterior moat (height now varying from 9/15 m to 3/ 6 m), probably form the emirate period, with 383.400 m2. Thought for a long while to be a roman military

camp, the absence of any credible findings and the comparison with Middle East military earthworks of the same type, gave it an emirate date (circa 977/988) related with an iberian campaign by Almansur (c.938-1002), in the center part of Portugal. These military camps with eartworks (named *qua'lat alturab,* the origin of the Spanish name of the military-religious Order of *Calatrava*), in some cases, were later to become cities

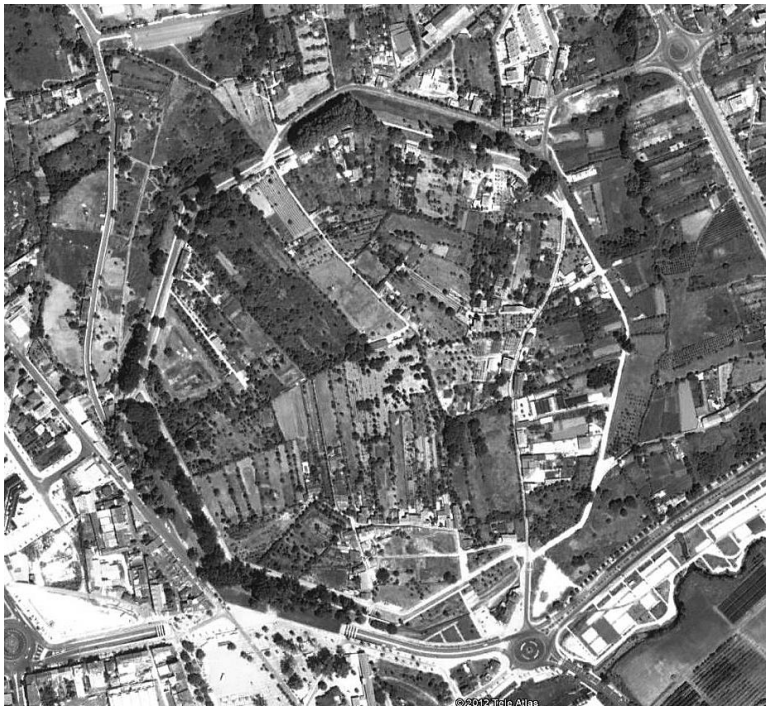


*Figure 51 Aerial view of "Cava de Viriato" , Viseu (Photo from the Google Earth)*

The portuguese archeologist, Helena Catarino gives us a perfect parallel in Husn al-Qadisiyya (CATARINO, 2005, p.202.), a camp-city of 1500m in diameter situated south of Sammara, near Bagdad. And founded by an abassid, al-Rashid, around 796. Other cities, namely in Syria have similar regular features, such as those in al-Raqqa.( Cf. NORTHEDGE, Alastair, *The Historical Topography of Samarra*, Londres, British School of

Archaeology in Iraq, 2008. Cf., "Creswell, Herzfeld, and Samarra", *Muqarnas. An annual on islamic art and architecture*, Univ. Leiden, Leiden, 1991, pp.74-93 (see http://books. Google.pt/books? q=qadisiyya)


*Figure 52 Aerial view form Husn al-Qadisiyya, Samara (Irak) (Photo from the Google Earth)*

An incredible change in scale (and size…), but sufficient to tell us about the importance of the geometrical patterns used even in the mightiest enterprises, as well as in regulated urbanism…!

## 6.3. An Almohad mosque in Portugal: Mértola

In Mertola lies one of the few examples of a preserved mosque, however transformed in a church during several campaigns from de 13$^{th}$ century onwards.

*Figure 53Nossa Senhora da Conceição church: early Mertol'a mosque. Mertola, Portugal*

Named Nossa Senhora da Conceição church, actually it was the main mosque of the city of Mertola (earlier known as roman Myrtilis) sitting ion the border of river Guadiana.

Two drawings by Duarte d'Armas, in 1510 (*Livro das Fortalezas*, fólio 5, c. e fólio 6, 1509-1510 (ANTT), depicts the temple in its earlier transformation form, that is, as a church but keeping the main features of the mosque(the legend says "*Igreja que foy mesquyta*"), that better reveals its Islamic origins: a rectangular volume buttressed on all sides with an unadorned the façade with a simple doorway formed by a semi-circular arch. The whole building volume was than topped by a multi-gabled roofdefinig by its shape the an interior with the five naves.

*Figure 54 Duarte d'Armas, Livro das Fortalezas, fólio 5, c. 1509-1510 (ANTT)*

*Figure 55 Duarte d'Armas, Livro das Fortalezas, fólio 6, c. 1509-1510 (ANTT)*

A high *almenara* or Moorish Minaret still seated next to one of the façades. It was later still, around 1530, that Dom João de Mascarenhas had it altered defining a single gable roof with cylindrical, Mudejar-style buttresses and with na exterior capped by beveled Moorish style merlons. In the interior the church is comprised of five longitudinal naves (one transversal aisle has

been sacrificed) covered by ribbed vaults built using almost all the original columns (BOIÇA, Joaquim; BARROS, Fátima, "A Mesquita - Igreja de Mértola", *Ordens Militares. Guerra, Religião, Poder e Cultura – Actas do III Encontro sobre Ordens Militares*, vol. 2, Lisboa / Palmela, 1999, pp. 341-365.). As Paulo Pereira puts it "*One of the most striking features was the mihrab, an enclosed prayer niche. The niche is ornately decorated with three multi-foil voluted blind arches supported by two pseudo-capitals.(…)"*

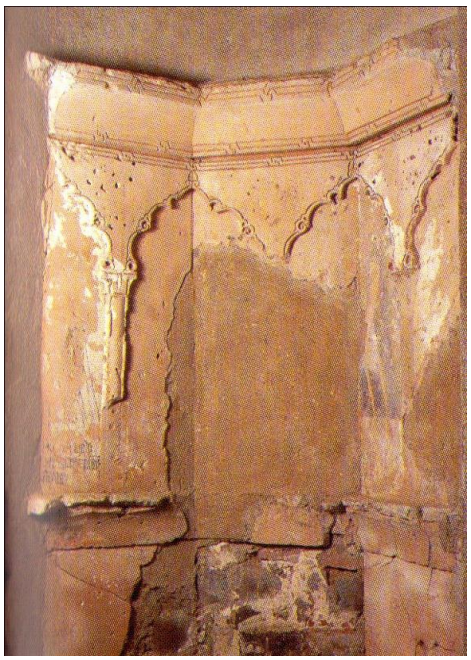


*Figure 56 Mertola's mosque mihrab*

*"(…) Higher up, the polygonal stucco panel on which the arches are engraved (once multicolored and gold) is capped by two moldings decorated with a rectilinear motif with well spaced curls — the well-known "endless" symbol of the infinite and of divine nature. The great* almenara *was taken down and replaced by a discrete campanile.* " (PEREIRA, Paulo, *2000 Years of Arte in Portugal*, Lisbon, 2000) [1].

[1] - Cf.

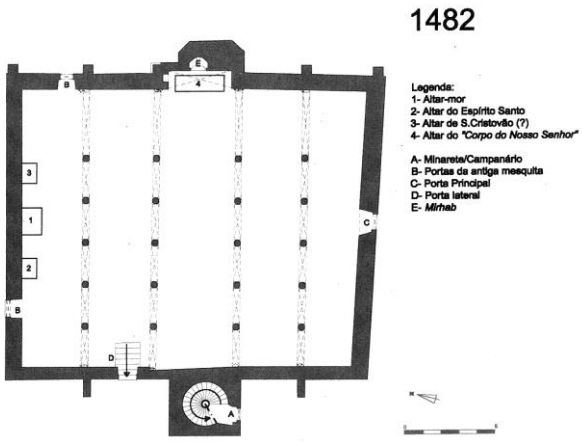



*Figure 57 Plan : circa1482 (in Boiça e Barros, 1999)*

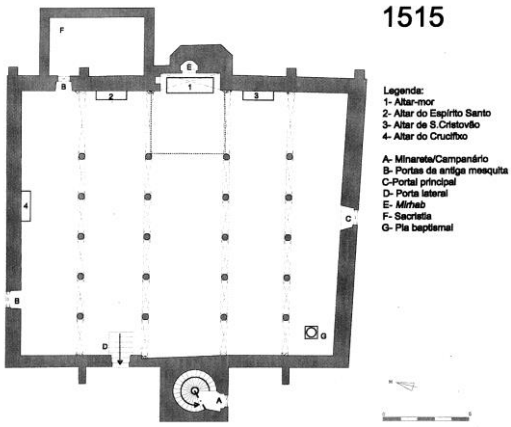



*Figure 58 Plan (circa 1515) (in Boiça e Barros, 1999)*

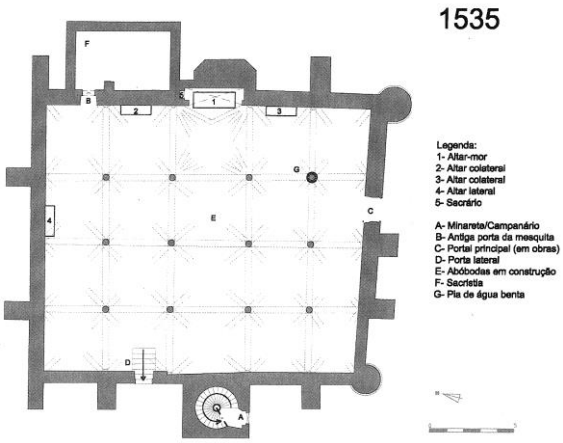



*Figure 59 Plan (circa 1535) (in Boiça e Barros, 1999)*

## 6.4. Azóias, arrábidas and morábitos

As far as other buildings are concerned, besides the doubtless temple of Idanha–a-Velha, maybe an early mosque transformed into a Christian church in the 12th century, there are Arab, Middle Eastern and Islamic heritages in small buildings, that miraculously survived in the country regions of the south of Portugal.

For instance the Azóias, a very common toponym in Portugal. The Word comes directly from the Arab (*zâwia*; plural: *zawâyâ*) and signals a place of spiritual and charitable gathering for Muslims, sometime associated to a tomb of a "santão" (in Portuguese meaning and saintly elder) Sometimes they gave way to "alcarias" or small villages some still exiting today. Another toponymic aspect that should be stressed is the "arrábidas" derived from the arab *ribât* (plural: *ribâtât*) , most of the time small fortresses or fortified "monasteries" (if we can call it this way), where those invested in the *jihad* (*tarîqa*), had their houses and oratories, and sometimes their own *madrassas* (schools) .

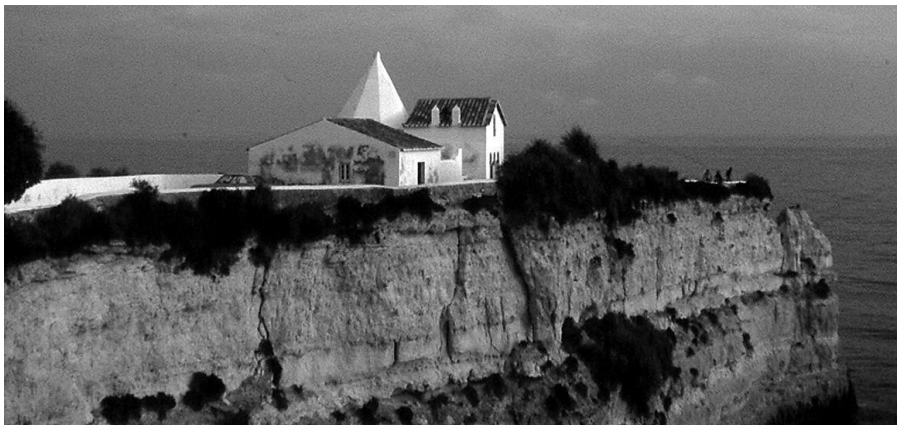


*Figure 60 Overall view of N.ª S.ª da Rocha (Lagoa, ALgarve), probably an early ribat*

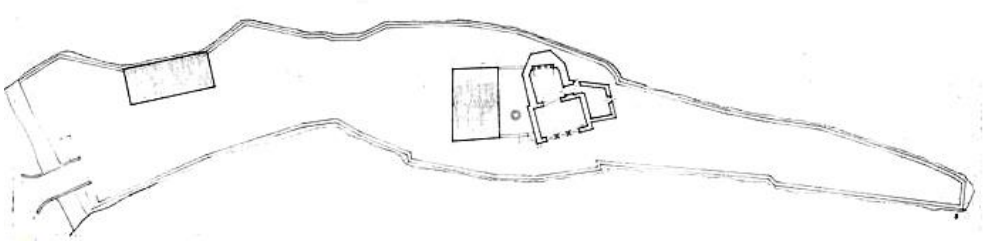


*Figure 61 Plan of N.ª S.ª da Rocha (Lagoa, ALgarve), probably an early ribat*

Other very modest elements in the Portuguese landscape are the "cubas" (meaning, "cube", not far from the meaning kaaba). These small monuments survived as small ortarories, christianized but, nevertheless of probable Islamic origin, sometimes with the same value and meaning as the morábito, a name still used in Portugal . They could have been, also, the place of entombment of "santões" or eremitic Sufi mystics.

The building materials are poor but vernacular, and of some of them have been built in the 11th-12th century, its shaped remained a rather common one, used in later Christian chapels from the 15th to the 17th century… They use *opus incertum* walls with chalk an limestone, with thick manufactured bricks (*tijolo burro*) and adobe or clay-brick even in the cupolas that invariable cover them built under the "abobadilha" (a traditional brick laying technique for imbricated cuppola building), hence resulting in cubic building with rounded cupola or octagonal roof and small pyramidal tips in the corners. The geometrical shapes are incredibly simple but they convey this sense of a centered plan and of controlled volumes of Islamic tradition.

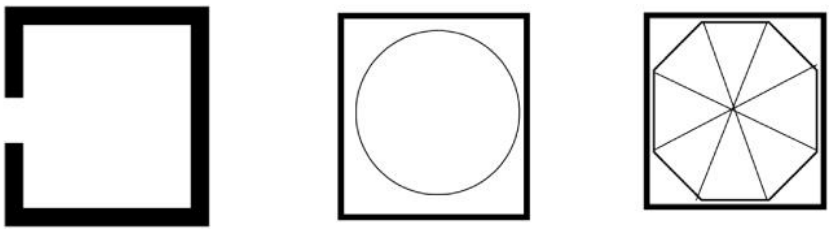


*Figure 62 Type-plans of morábitos (Pereira, 2012)*

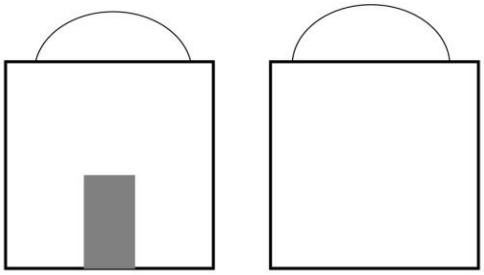


*Figure 63 Type-elevations of morábitos (Pereira, 2012)*

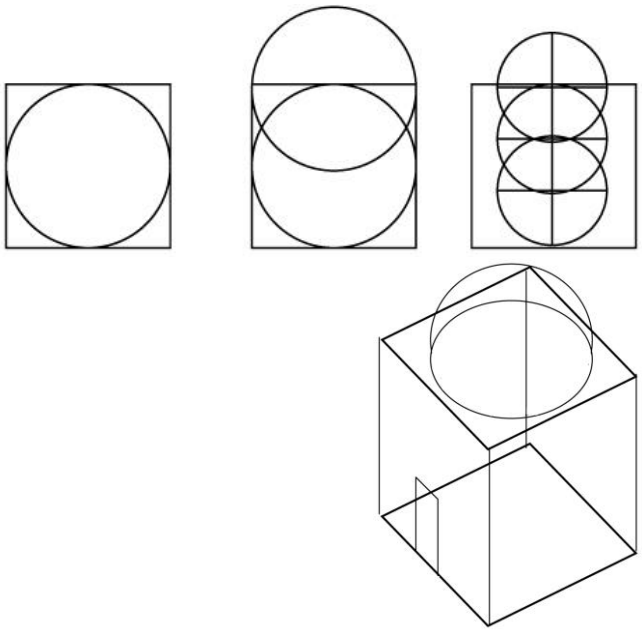


*Figure 64 Geometrical generation of the types based in the cubic volume (Pereira, 2012)*

CHAPTER 7

# ISLAMIC GEOMETRIC PATTERNS IN PORTUGAL

# 7. ISLAMIC GEOMETRIC PATTERNS IN PORTUGAL

## 7.1. Azulejos

### 7.1.1. The origin of the name

As a result, it is possible to observe, even nowadays, several examples of Islamic influence in art and architecture in Portugal. As was said above, the geometric patterns are an important part of Islamic ornamentation, and we have registered many cases of its usage in Portugal. This use is more noticeable in Portuguese tiling - "azulejos", than in other artistic records. Nevertheless, besides "azulejos" there are also large samples in “alfarje, stained-glass windows, pavements, and stucco, as well as, plaster works in Portugal.

Azulejos basically could be explained as Portuguese and Spanish tiles.

The first tile manufacture in Portugal is dated to 12th century based on documentary source from Coimbra, in which reference is made to tile factories.

However, Hyspano-Moresque tiles appeared in Portugal and Spain in XV – XVI century.

*Figure 65 Ceramic floort tiles from Leiria Castle. XV - XVI centuries. Leiria, Portugal (Photo from the book "Portuguese Tiles from the National Museum of Azulejo, Lisbon" )*

*Figure 66 Loseta and alfadron tiles manufactured in Manises. From the former Palace of Infant Princes. . Middle of the XV centurie. Beija, Portugal (Photo from the book "Portuguese Tiles from the National Museum of Azulejo, Lisbon" )*

A remarkable number of them were produced in Seville and are more similar to the ones existing in Spain. Indeed, the ceramic tiles of that period were designed following all the rules. Nevertheless, later on, we could find them slightly changing forms. However the rules in mudejar ornament glaze tiles follow the strict geometrical arrangement from the Islamic sources.

Azulejos basically could be explained as Portuguese and Spanish tiles. The first tile manufacture in Portugal is dated to 12th century based on documentary source from Coimbra, in which reference is made to tile factories.

There are some examples of patterns in Portugal dated from the 13$^{th}$ century: in the Leiria castle or in Cistercian abbey at Alcobaça. None of these productions have a direct relationship, however, to what we now call azulejo in a generic matter-of.-fact expression, designating a glazed tile

decoration type Islamic and middle-eastern or Western European Moresque influence or direct inheritance.

The first Hyspano-Moresque tiles appeared in Portugal and Spain in XV – XVI century.

The first they started to be used in Spain, Seville. Seville become the major center of the azulejo industry. It took over a Moorish tradition of making *tilis – zilij*. It is the name of ceramic tiles made of terracotta. The art of zilij also was floured in Hispano-Moresque period in Morocco. At that time there was Egyptian *zilij* and the Moroccan *zilij* as two main traditions of making tiles. It could be considered as the same thing that the azulejo, but *zilij* are the tiles that generally was made in Morocco. The small shaped and colored pieces of tiles are connected in a puzzle in geometric structure. These knowledges as in the other types of craftsmen art was transmitted from generation to generation by *maâlem*s (master craftsmen).

By adopting the azulejos from Spain, they have adopted also the word "azulejo". Despite the fact that this word is came into Portuguese from the Spanish, the origins of that word are much more complicated.

"…At first the term was used to denote only North African mosaics, but it became the accepted word for an entirely decorated tile about 5 to 6 inches (13 to 15 centimeters) square…"

Etymologically the word "azulejo" have two versions of defining. In the both versions, this word has Arabic rotes.

The first version of the origins of the word "azulejo", which we could meet while searching for azulejos, goes back to Arabic word اَلزُّلَيْج ( aal-zulayj ). The word "az-zulayj" sounds very close to the word "azulejo". It means a polished stone, earthward or small stone.

At the same time the word "azulejo" has in Spanish different meanings as the names of birds and a flower: European bee-eater, indigo bunting, blue-

grey tanager and cornflower. All of those living being are colored in blue color.

When we search for the word zellige, zillij or zellj (زُلَّيْج zuleyj and زَلِّيج zaliyj) – Moorish decorative tiles, we see that it shares the same etymology with the word azulejo.

The second version is the originating of the word azulejo to the word "azul", which means blue in Spanish and Portuguese. It could be explained, as the most popular glaze color that covered azulejos was blue.
Most of the scientists think that it is impossible because the blue color in the manufacturing of azulejo appeared much more lately than the word "azulejo".
But when we take a look to the etymology of the word "azul" we could see also the Arabic and Persian origins.
Directly impact to the Portuguese and other European languages (Spanish, Italian, English etc.) came from the Medieval Latin. Lapiz lazuli or lapis (briefly) is a Medieval Latin word used to call a blue semi-precious stone, which were used since antiquity for his intensive color. At the end of the middle ages this stone started to be exported to Europe.
This Latin word was adopted from the Arab word lāzuward ( لَازُوَرْد ), which was in turn adopted from the older Persian lâjvard ( لاجورد ). But this versioun, despite of its prevalence, not justified. (Meco, 1998) (Gwinn, 1990)

### 7.1.2 The portuguese Mudejar context (hispano-moresque)

The word "azulejo" became a benchmark designation as the name began to spread from Seville and overall Spain to Portugal, since the

manufacturers of azulejos were of Arab origin and of Muslim religion, or mudéjares. Some of them later known, in Portugal, as "*mouros forros*" and in Spain as "*sometidos*" –free from any slavery prejudices or dangers yet marginalized in ghettos (*mourarias*), becoming what was later to be called the *mudejares*. And *mudejar* became, also a term to define that peculiar kind of Middle Eastern art used in the Christian courts of Iberia since, at least, the 13th-14th century.

Therefore, it was through decorative arts and architecture implements that the Mudejar style began "*to catch on*" (Pereira, 2000). Its influence in Portugal, however, was not as great as in Spain. Actually, in Portugal, the Mudejar style adoption is difficult to follow. As Pereira suggests that "*Some believe that Mudejar or Moorish 'genes' lay dormant before awakening particular styles and tastes — as we shall see further on. Its natural epicenter would have been the Alentejo, the south of Portugal, the earliest Islamized region in other words. Others believe the Mudejar style to have been directly influenced by Moroccan art from the beginning of the 15th century thanks to territorial expansion in North África; yet others believe it to have originated from the importation of decorative motifs and materials from the Maghreb and from neighboring Spain.*" (Pereira, 2000, p. 93)

The best explanation, however, is the one that derives the taste from the great Portuguese nobility involved in wars in Magrib since the early 15th century, becoming acquainted with new objects and art. But specially it was an episode of enduring influence: the voyage of King Manuel and his first wife, Isabel, to Spain in 1495, where he visited the great centers of the Spanish Mudejar style such as Toledo and Granada, and becoming attracted by the cheer richness and fufilness of Moorish art. "T*he taste of the Manueline court –Pereira says- , is one of the most tempting explanations*" even if it

"*does not explain the presence in Portugal of Spanish or Moorish officials on previous works — during the reign of, Afonso V or John II — which denotes the attraction for this type of decoration*".

It must be said that the south of Portugal, as we've already stressed, made this region with urban centers in Beja and Évora "*a convenient receptacle for the Mudejar style*". This created a a trend for "Spanish" Mudejar taste and led to imports from Toledo to Granada, Córdoba to Málaga, mainly of azulejos, and becoming a model of noble comfort and prestige, adopted by the king himself and followed shortly after by the nobility and even the church, in an usual imitation of the proclivities of the main elite. The masters of Mudejar art became famed and consequently were called to building enterprises in Portugal, such as the *alarifes* (master builders) or carpenters of the extremely complex *carpinteria de lo blanco* — wood tracery – where the moors excelled creating, even a "school" and a strong tradition within Iberia and even in Central America…! [2]. From the late 15th century till the mind 16th century the art of ceramic surfacing or glazed tiles imported from Andaluzia in great quantities "*aroused growing interest*".

[2] - Alfarje (Alfarge in Portuguese) is a type of wooden ceiling decoration, mostly encountered in Islamic and Moorish architecture. This type of ceiling decoration is structured by beams grid. Those beams are placed to cross each other perpendicularly and are designed to support the roof. But often simple grid design of alfarje was decorated with moldings carved in geometrical patterns. We could see a lot of examples in architecture of Spain and a few exists in Portugal. They were used mostly in churchs. See an example of alfarje in the church of Sao Pedro, Castelo Mendo.
In the Church of São Pedro de Castelo Mendo (located in the municipality of Almeida, Guarda District of Portugal) the Islamic patterns appear on the roof decorations. The construction date of this church goes to the after Muslim period in Portuguese history, but it shows how influential was five centuries of conquest's affect. It is not the only building with that kind of roof decorations; there are more in Portugal and particularly in Lisbon. It is important to notice that this pattern is one of the most popular patterns in Islamic ornamentation.
One of the most beautiful pattern application methods is the use of them in vitrages. An example decorates the ceiling of the Arab room of the Palácio da Bolsa in Porto (see fig. 4). In the same room, there are stained-glass windows with modified Islamic geometric pattern. This building dates to 19th century.

"*The Mudejar style thus spread throughout Portugal, to regions with little or no Islamic tradition such as the Minho district or the islands of Madeira and Azores! It then became a fashion, one with very evident political overtones during the Manueline period.*" (Pereira, 2000).

That was one of the reason for the incredible spread of Islamic theme and geometrical patterns in decorative arts applied to architecture, in which the azulejos and the *alfarge* ceilings are thought to be some of the more definitory masterpieces of the time. "*The Mudejar style, therefore, is an example of the assimilation of Moorish taste even if it only reached its height during the Manueline period. Its importance was such that the unique Mudejar style (together with Gothic) gave rise to the designation that during the 16th century began to distinguish Iberian works of art, in counterpoint — or even in opposition — from other styles: they are works of art* ad modum yspaniae, *in other words,* in the manner of the Spains*." (Pereira, 2000)*

Figure 67 *"Azulejo" decoration in the Convent of Christ, Tomar. (Photo by Gomes Januario P.M.)*

So the azulejos became one of the most important elements of Portuguese art and architecture. Several monuments, either palaces or churches used it as a way to enrich its interior (and sometime, later on, its own exterior), giving a special refraction to the walls and a protective and qualified ornament to the walls, changing even the own perception of space, and giving a much more sundry and colorful variegated distinctiveness to the walls, either way just stuccoed or white washed, make this impact visible. They are most obvious in Sintra. The Arab room of the Sintra National Palace is decorated by those azulejos.

*Figure 68 Sintra Royal Palace: Sala dos Árabes: aresta azulejos with gothic design crowning a composition of corda-seca azulejos with Islamic patterns (Imported from Seville)*

We can observe Islamic geometric patterns on the azulejos of the Hispano-Moresque period (c. XIV-XV). A remarkable number of them were produced in Seville and are more similar to the ones existing in Spain.

### 7.1.3. Azulejos types

After the *alicatado* (curring tiles to the shape and imbedding them in compositions of highly complex geometry) One of the methods of creating azulejo is by the system named "cuerda seca" (spanish) or "corda seca " (Portuguese). It means "dry cord". This method is based on glazed drawings applied on ceramics. They were used together on a flat tile. During the process of firing this colored glazes connect with ceramics.
The definition of the spaces and of the divide between the colors was obtained through the drawing lines imprinted by a mold, creating thin furrows in which an also thin rope was imbedded, previously rinsed with linseed oil and manganese oxide, using a mixture of dark ceramic pigments and a greasy substance that keeps the water-based colored glazes separate from each other. The grease burns away during firing and leaves a thin, sunken, unglazed line between the slightly raised glazed surfaces. (Meco, 1998)

*Figure 69 Corda-seca azulejo, Museu Alberto Sampaio. XV - XVI centuries. 10,1 x 10,1 cm. Guimaraes, Portugal. (Photo from the Database of Islamic Heritage in Portugal)*

The second important technique, which we observe in Portugal, is the technique "cuenca" in Portuguese know as the "aresta" technique. This technique was adopted as an alternative to the corda-seca, more apt for the kind of linear geometrical patterns from direct Islamic influence, while aresta responded more often and then becoming the major technique to renaissance or mannerist patterned azulejos. Is consisted in a mold, with a drawing, applied to the still moit surface of the clay, creating a depression or several depressions following the main theme or design. The depression was filled by the colors that were keep, thus, separated from each other during the baking in the oven,

The colors or paints used were in either of the methods, manganese chloride or blue cobalt (blue), copper manganese (yellows, shades of green,) iron manganese, red lead ("zarcão") (black), simple thin (white), cobalt oxide and manganese (pink and deep red)

*Figure 70 "Cuenca" or "aresta" azulejo*

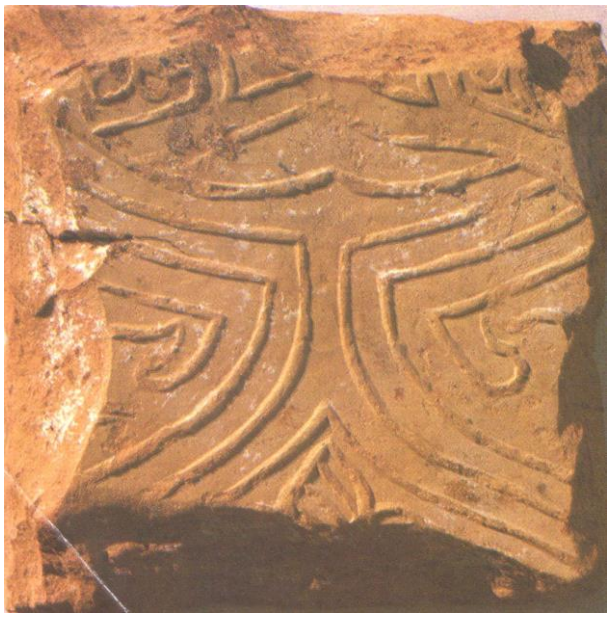


*Figure 71 Aresta technique*

*Figure 72 Azulejo (from Toledo) painted with "aresta" tehcnique*

*Figure 73 Aresta azulejo with a mannerist theme*

The use of azulejos tiles was to be continued even if the theme or geometrical pattern changed. It was a groundbreaking expedient, as we've said, to transform otherwise poor or banal interiors into chambers and rooms of lavish decoration and nobility. We'll see that one of the characteristic of azulejos is his endurance: and for most of the times,

forgotten or leftover were used, as we can see in the decoration of the tree bed in Tomar.

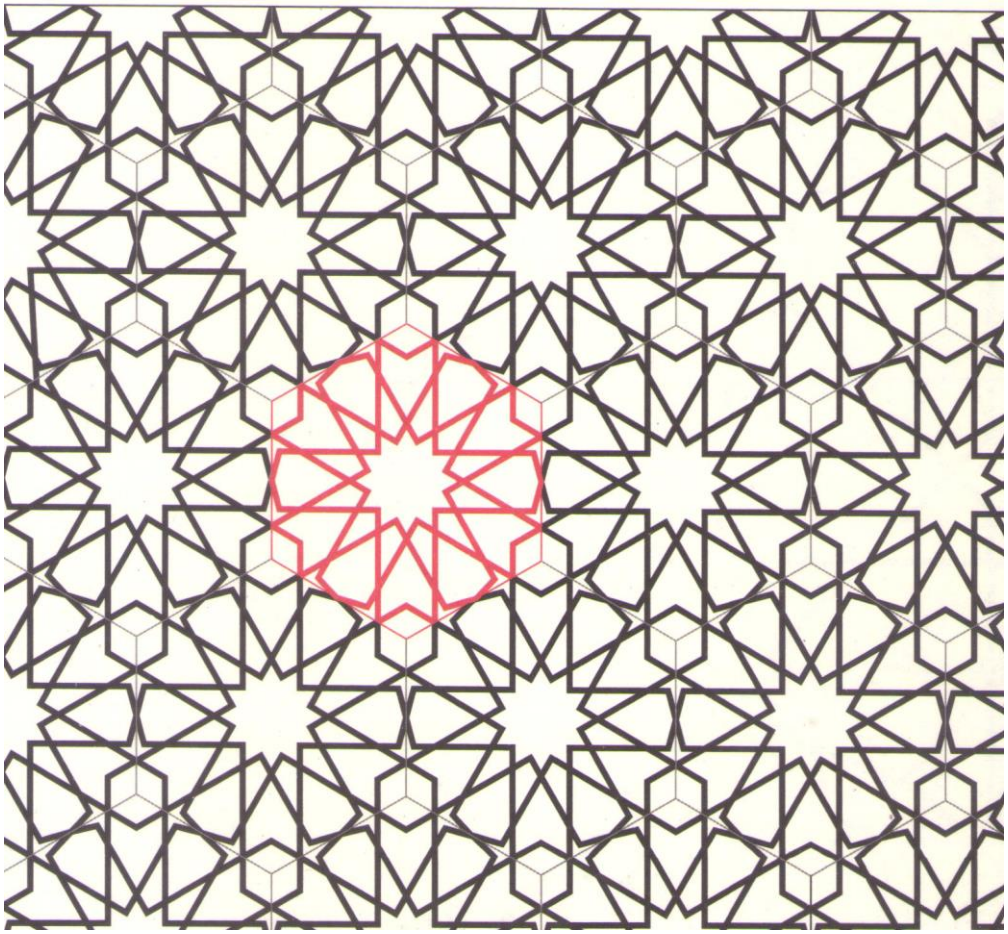
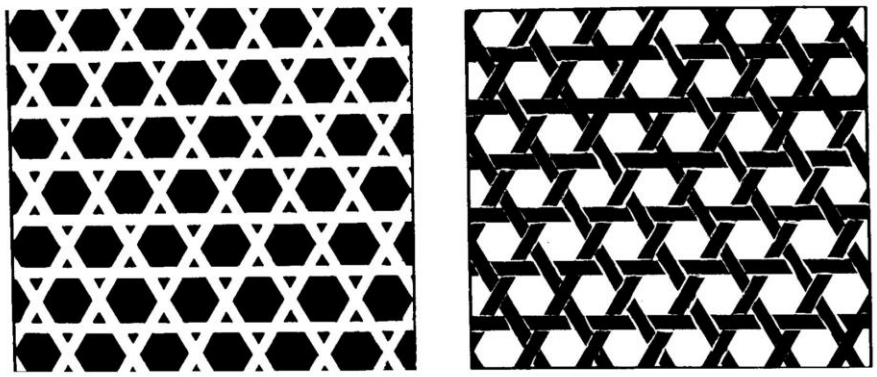


*Figure 74 Al-Nasir Muhammad mosque in Cairo, Egypt (1318). (Eric Broug in his essay Islamic Geomteric Patterns (s.d.).) account*

Among the most used geometrical themes are the "stars" which were used seldom in the Magrib and the Middle East, namely in the al-Nasir Muhammad mosque in Cairo, Egypt (1318). This is just an indicative element between the several ways of tracery and geometrical patterns.



It should be noted, once again that, "*Islamic craftsmen excelled in such virtuoso performances, which we shall encounter again. They were capable of further enrichment by departing from the monothematic principle and decorating the geometric interlace with floral designs or stacking the ornamentation with the links emerging from under the motifs and crossing further framing devices*" (Gombrich, 2012)

But we can see here the generation of such composite structure through the work of analysis led by Eric Broug in his essay *Islamic Geometric Patterns* (s.d.). It gives us an account of the practical geometry involved in such works, even knowing that the result would be a model or mold applied universally in serial repetition. The invention of the variation is, in itself a token of the depth of Islamic geometry and numerology.

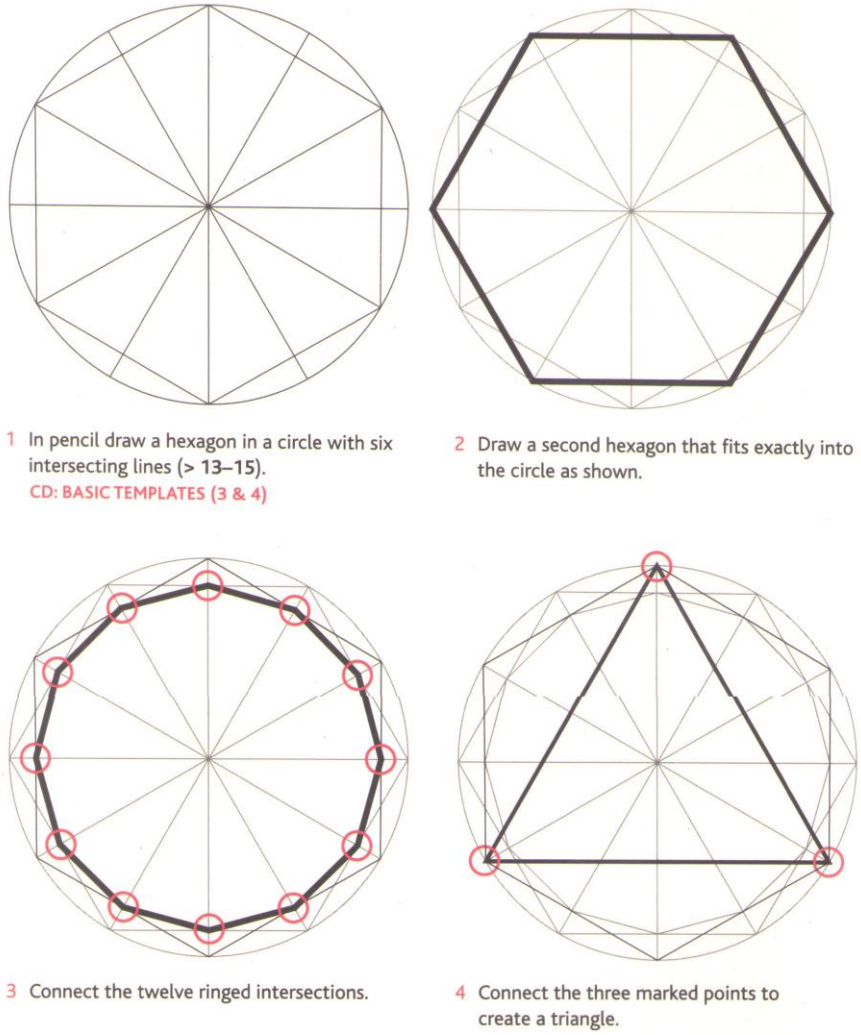



*Figure 75 Al-Nasir Muhammad mosque in Cairo, Egypt (1318). (Eric Broug in his essay Islamic Geomteric Patterns (s.d.).)*

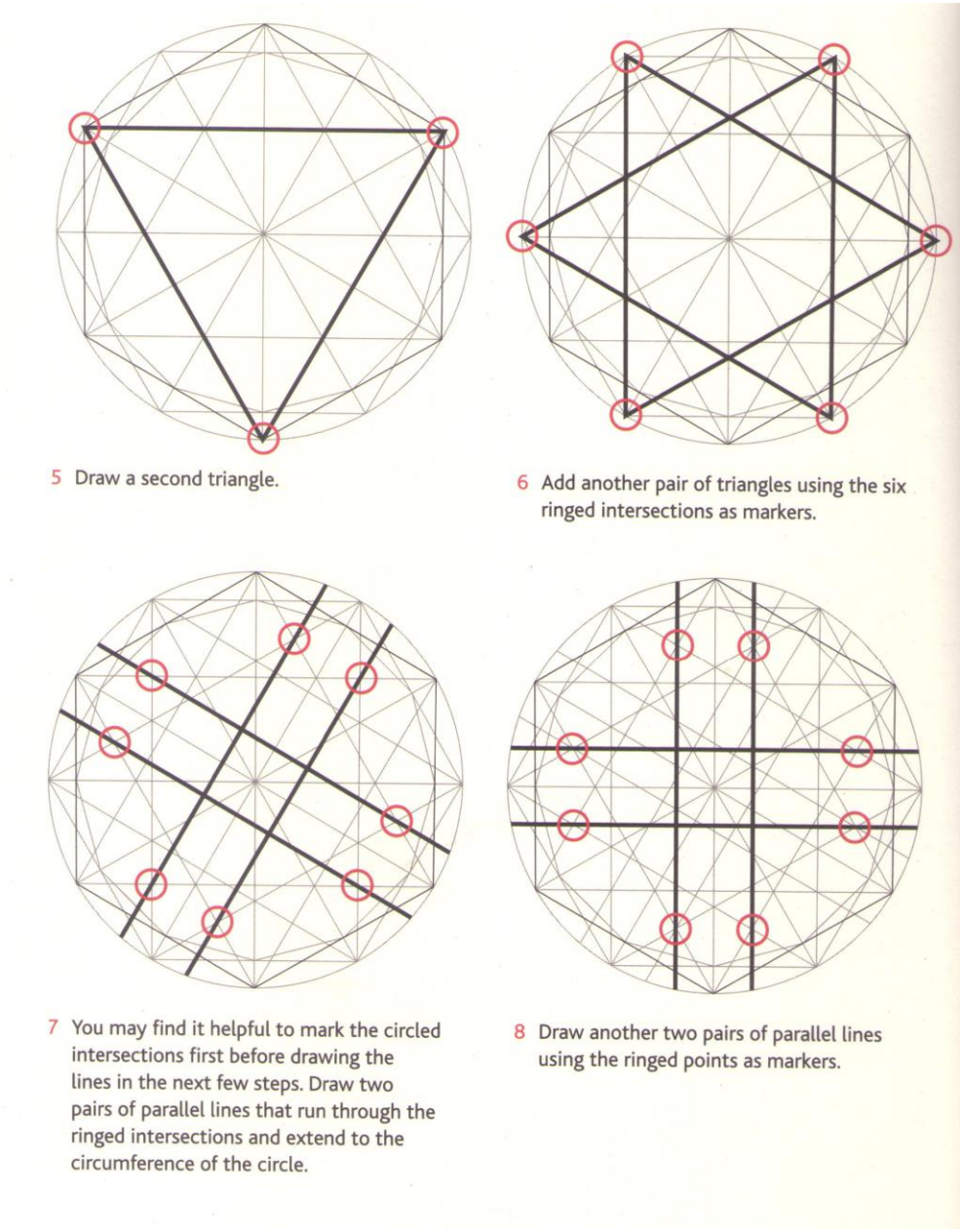



*Figure 76 Al-Nasir Muhammad mosque in Cairo, Egypt (1318). (Eric Broug in his essay Islamic Geomteric Patterns (s.d.).)*

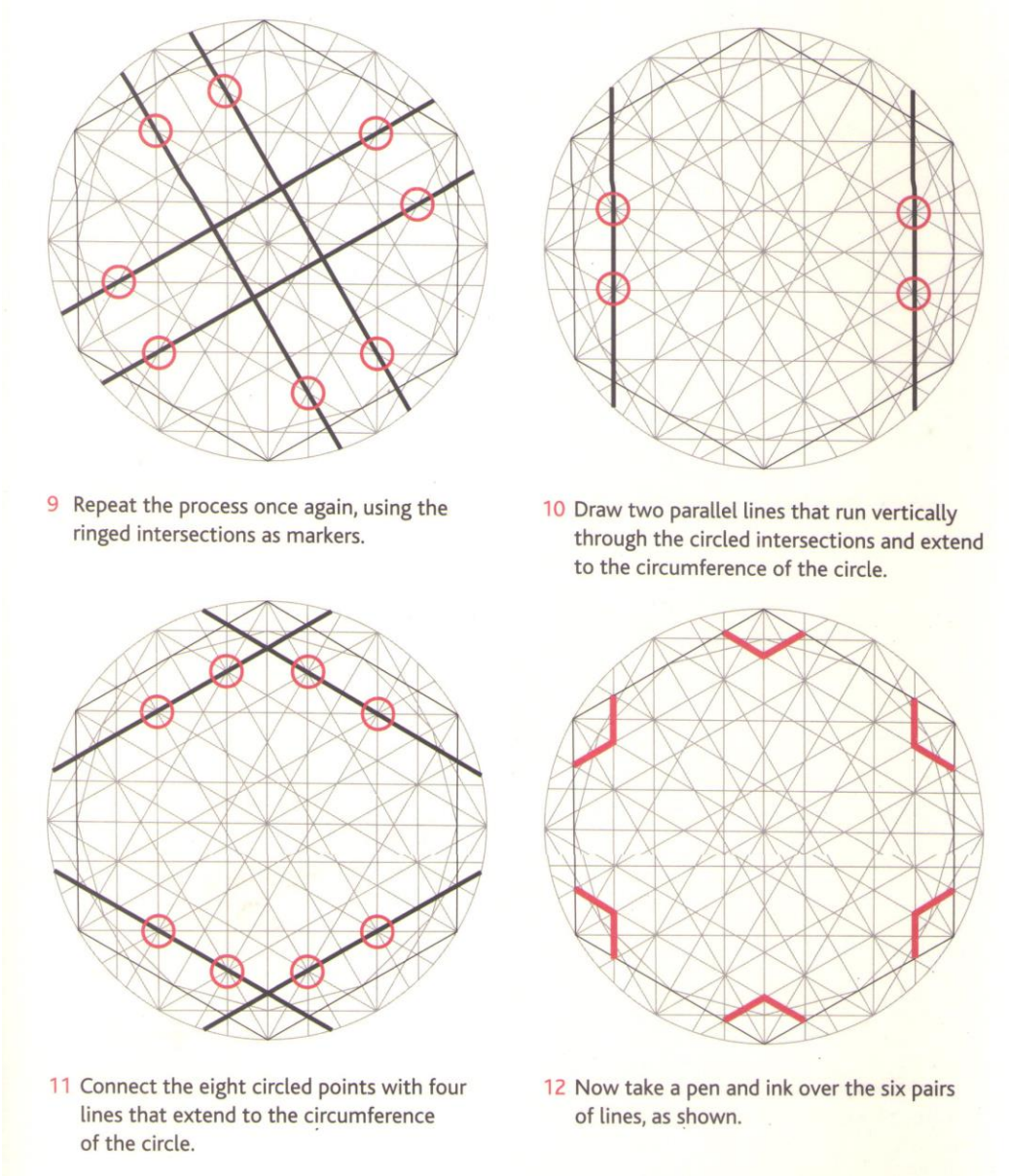



*Figure 77 Al-Nasir Muhammad mosque in Cairo, Egypt (1318). (Eric Broug in his essay Islamic Geomteric Patterns (s.d.).)*

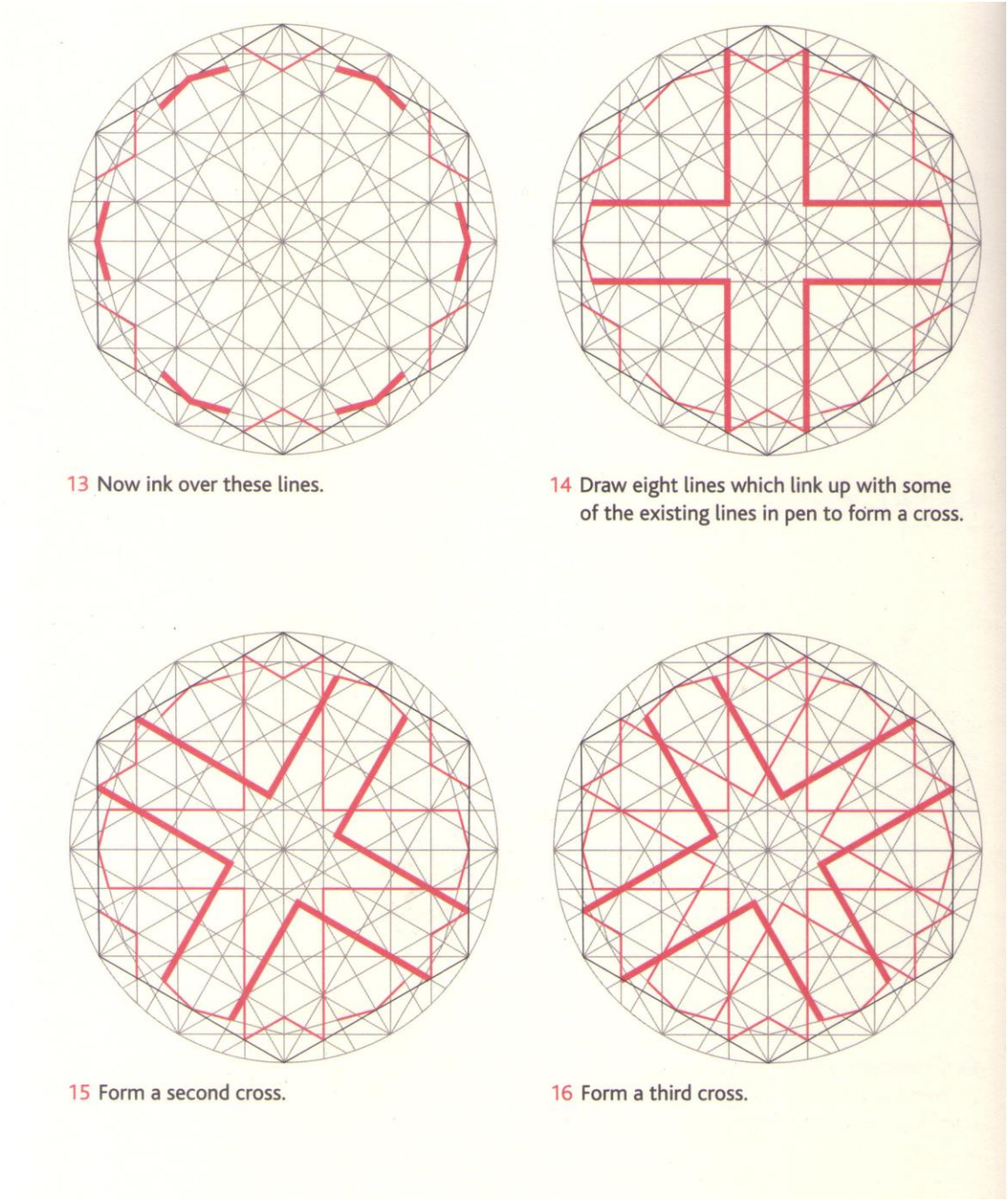



*Figure 78 Al-Nasir Muhammad mosque in Cairo, Egypt (1318). (Eric Broug in his essay Islamic Geomteric Patterns (s.d.).)*

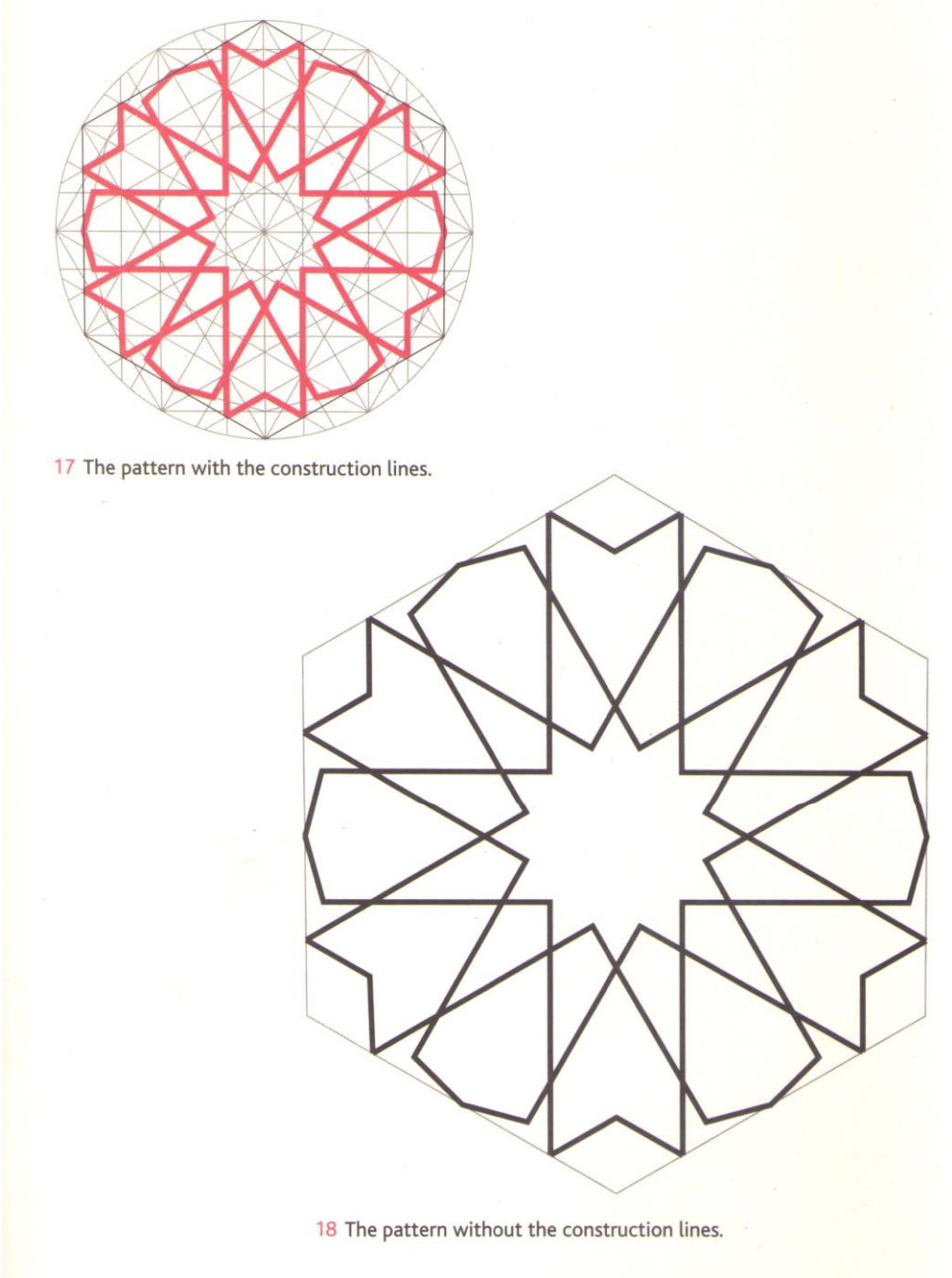



*Figure 79 Al-Nasir Muhammad mosque in Cairo, Egypt (1318). (Eric Broug in his essay Islamic Geomteric Patterns (s.d.).)*

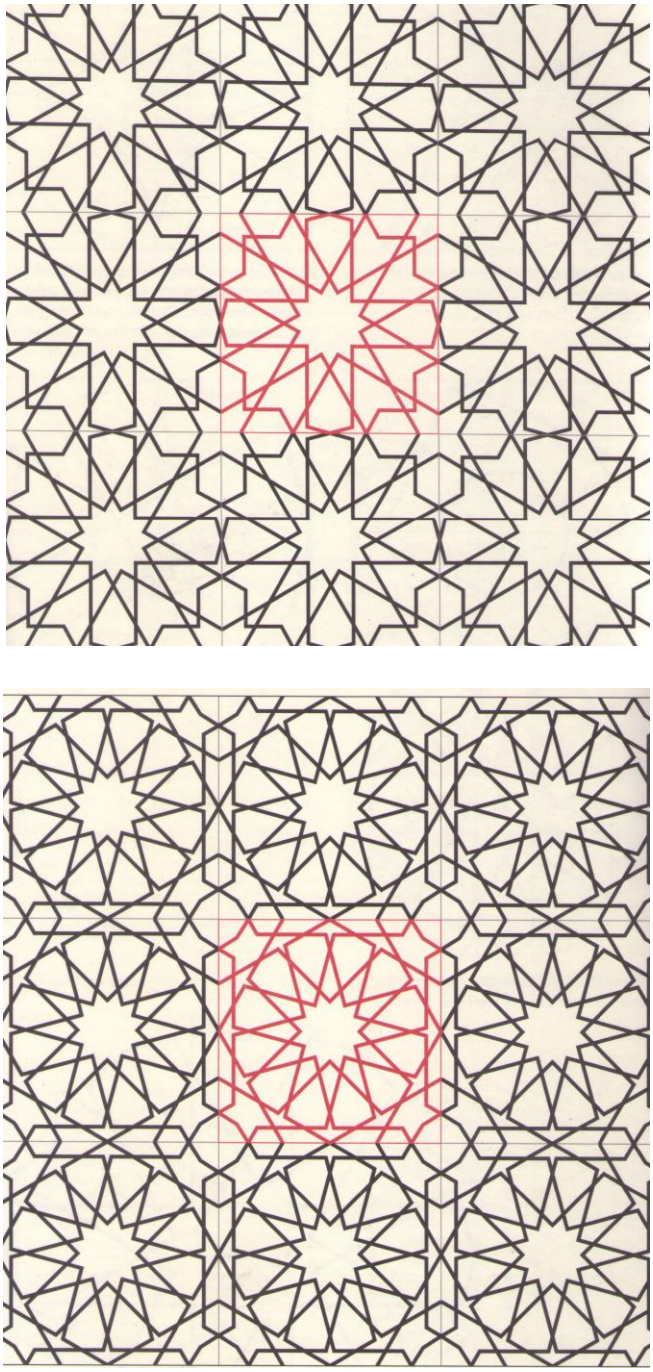


*Figure 80 Other main designs from Midlle Eastern (13th-17th century glazed tiles (Eric Broug in his essay Islamic Geomteric Patterns (s.d.).)*

On the other hand, we already know that for the most part if not for all of them in the first half of the 16th century they were to be imported from the mains centers of production in Spain. Those centers specialized in certain types of motifs, ranging from the Islamic traditional motifs, from Andaluzia, to the renaissance and mannerist motifs, some of them influenced by Italian majolica but also by mannerist engravings of patterned type ornament of Flemish origin.

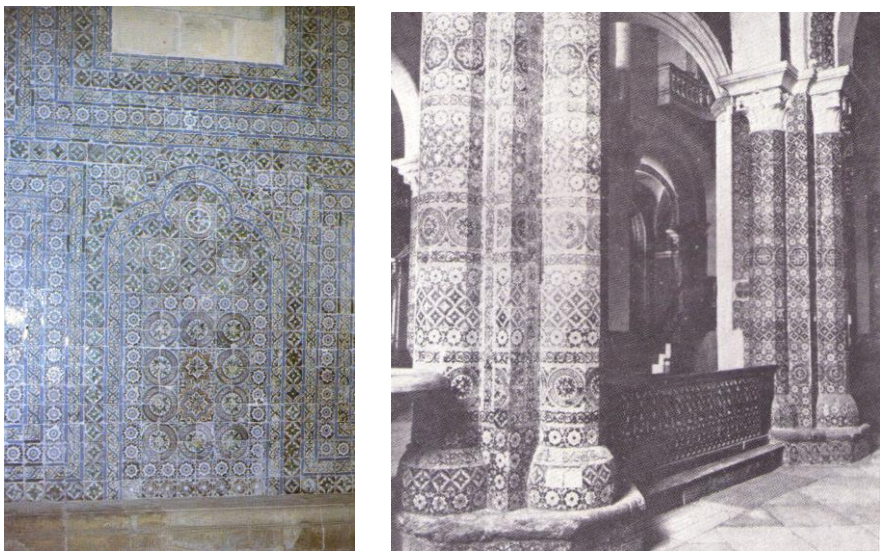


*Figure 81 Coimbra Cathedral: remaining wall with tiling; columns in the nave wirh tiling, now partially destroyed (circa, 1500-1510)*

Moreover, here is something that pervading the use of azulejos anywhere became sometimes different within some aspects of its application by the "ladrilhadores" (tilers). In churches such as Coimbra cathedral for instance one could find fully lined walls and columns. The compositions were, in a certain extent used free from any prejudices and went the treatment that the tilers thought would be the most appropriate to a maximum effect.

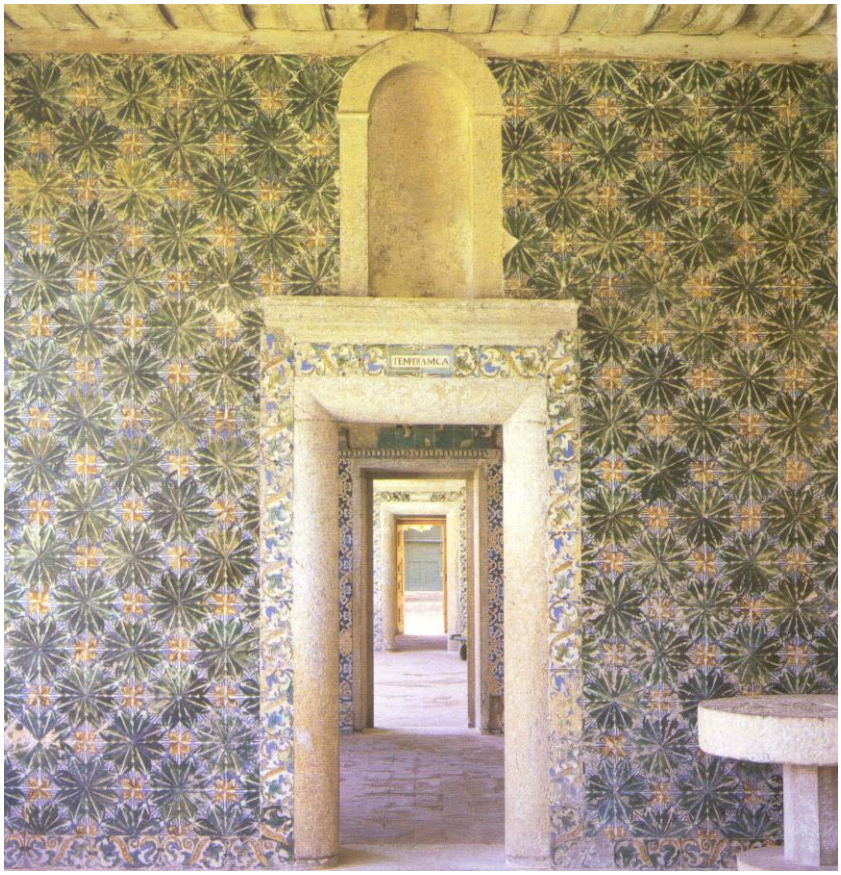



*Figure 82 The use of Seville islamic patterned azulejos (circa 1520) in the Renaissance "Casas de Fresco" in Bacalhoa Palace, Setubal (built circa 1560), combined with Talavera (?) glazed tiles circling ythe doorways from circa 1570.*

### 7.1.4. Portuguese 17th century pattern azulejos

In the mid-16th century, there is another kind of pattern or, to be more precise, "non-patterned" azulejos. The units are monochromatic –white, blue, green – and it's the combination of these lattices in a wall or surface that give them the patterned form. These are very simplified glazed tiles, easily produced in workshops around Lisbon, and used as ornament in several buildings, when they combine two main colors: white/green or

white/blue, in squares, rulers and grids, with no intricacy. That's what is called "*enxaquetados*" - or chequered azulejos

*Figure 83 "Enxaquetado": basic morphological unit (Convento de Jesus de Setúbal, late 16th cent.) XVI.*

What happens even if we look to these simplified grids is something that, in terms of *gestalt* or psychology of seeing, is a trademark of Islamic patterns, only here much more simpler and even quite basic.

The hierarchy of the arrangement drives our perception, our way of reading the pattern, framing it, and conducting/directing it, the result being to "catch" the eye in centralized motifs or, alternatively, to "steer forward" with the rulers/grid motifs  But, in a sense, it's the minimum decorative support that gives us this inter-relationship between basic *morpheme*, which become a grammar of its own, with a syntax.

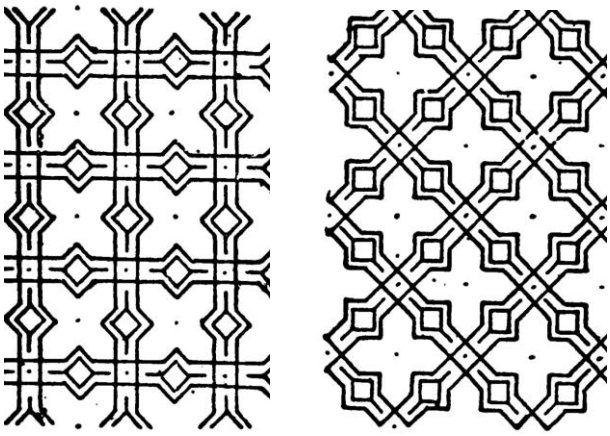


*Figure 84 The effect of tilt. Same theme different tiltings: H. Mayeux, 1894 in Gombrich, 2012, p.133*

As Gombrich puts it: *"Like all psychological mechanisms the compulsion for our eyes to run along the established rails of redundant repeats can be used by the designer for contrasting effects. He can use it to enforce a reading or to unsettle our perception in a most disturbing way. The first possibility is brilliantly demonstrated in the book* Gesetze dês Sehens *by the* Gestalt *psychologist Wolfgang Metzger. He shows us two geometrically identical grids with different terminations (…). Where the stars are jutting over the edge they acquire a prominence that makes us notice the stars throughout; where the squares stand out from the field it is they which dominate the appearance of the pattern."* (Gombrich, 2012). Keepiing up with him:

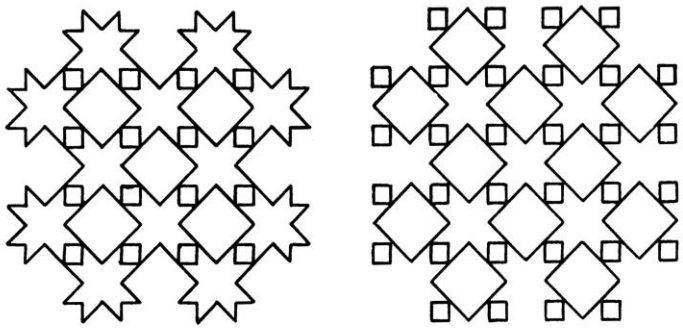


*Figure 85 The border effect. Same theme differente borders: W. Metzger, 1975 in Gombrich, 2012, p.132*

"*More interesting, because less frequently discussed, is the ambiguity of simulated transparency, which again permits us to observe the continuity principle baffled by ambiguity*." (Gombrich, 2012)

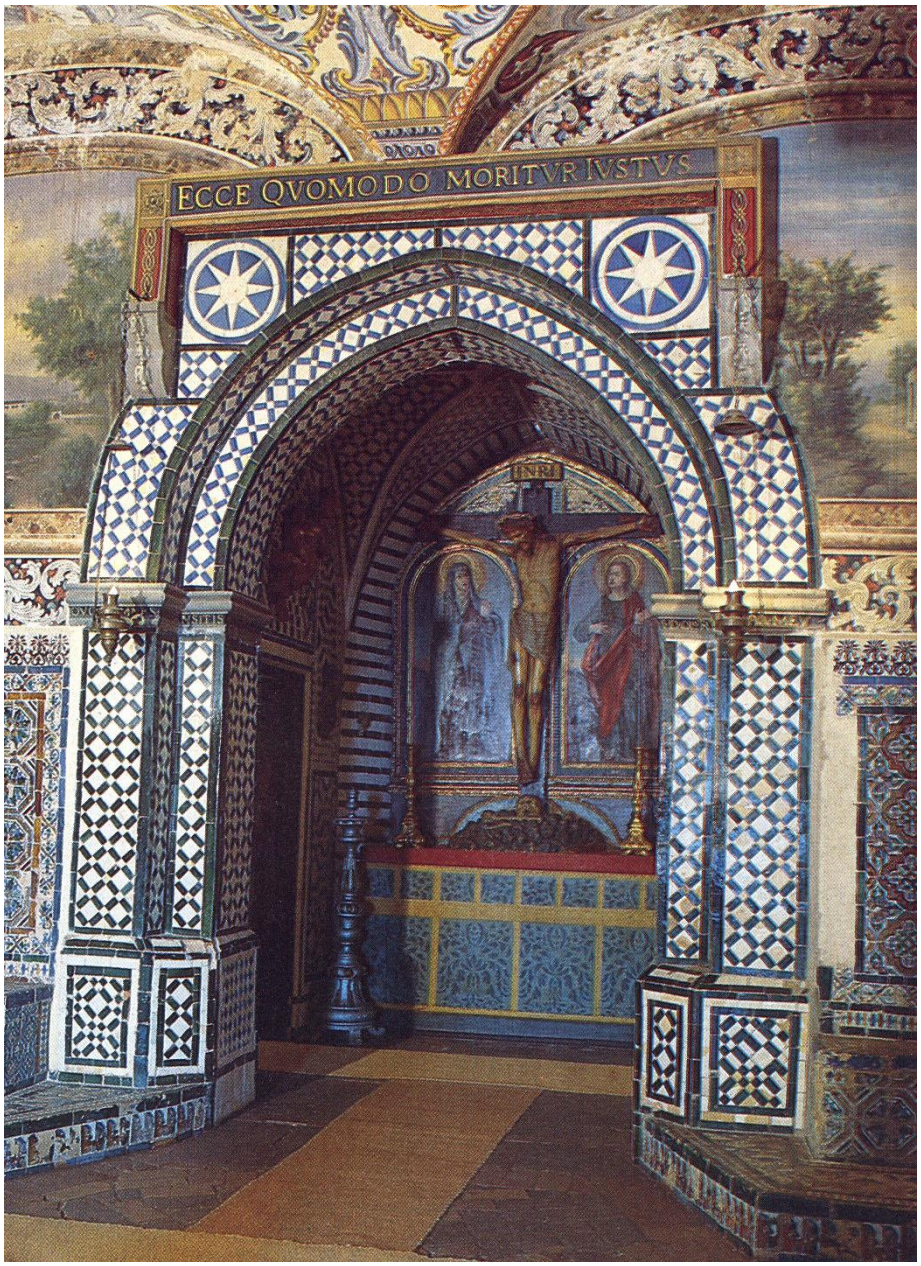



*Figure 86 Chequered azulejos composition in Convento da Conceição de Beja (c. 1600)*

*Figure 87 Chequered azulejos composition in Convento da Conceição de Beja (c. 1600)*

What has been shown before is a good introduction for one of the tendencies of Portuguese azulejo during the 17th century, which is, in our opinion, a quite original one.

As we know, it has everything to do with Flemish ornament influence, and Dutch glazed tiles,. However, a phenomenon such as the import of porcelain from China and, in general, all China ware, as well as the beginning of the production of faience from the mid 16$^{th}$ century onwards, boosted a local azulejos production. This azulejos were influenced by "single figure" ("*figura avulsa*") azulejos from Holland, but in a moment the manufacturers were translating simples ornamental forms used in faience, and with the painting technique of «faience –much cheaper ones, made in plain tiles with a limited choice of mineral colors (resulting in blues, whites, blacks and yellows)- became prominent, specially in large and serial produced panels.

Also the imitation of tapestries and rugs, commonly used in rich house hanging from the walls to increase interior and domestic comfort influenced the arrangements of these shapes. In matter of fact, the tapestries found in palaces were imported from India and the Far East. In addition, for that matter, the rugs and tapestries showed an array of geometrical or at least symmetrical arranged items, with an edge. That was thus imitated as a limit to those panels as large margins, defining the inner geometrical repetitive theme and surrounding the overall panel thus obtained.

*Figure 88 Monochromatric azulejos. Typical 17th century composition.*

This is the beginning of the fusion of azulejos "de tapete", something we could translate as "tapestry" azulejos), a well known designation in Portugal: "*azulejo de tapete*". They became a trademark in large panels applied into the walls of rooms and churches of all kinds and dimensions. The secret is to fill, a basic shape and to make it more complex. This method was used by Islamic patterns and it became a normal attitude of the manufacturer that based his basic theme in a centered drawing taken out from a rug or tapestry (tapete).

*Figure 89 Pattern filling: gradual compelxitiy. From A.H. Christie, Pattern Design, 1929, in Gombrich, 2012, p. 80*

*"If such 'filling in' is the immediate response to the* horror vacui, *linking is the most sophisticated. Any regular lattice or symmetrical design is always capable*

*of further development by the creation of links between its constituent elements. In this process a rich network of progressive intricacy can be seen to emerge, for it is in the nature of any geometrical periodicity that it can serve to generate fresh periodicities in a hierarchy of forms (…)*" (Gombrich, 2012)

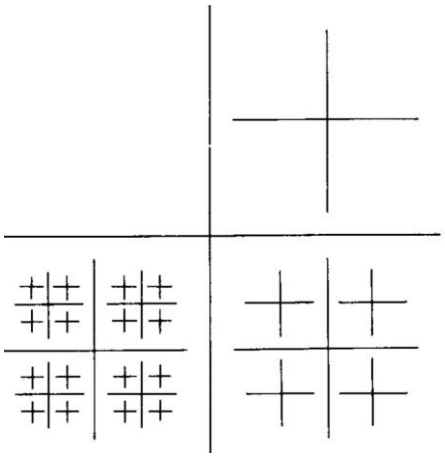


*Figure 90 Proressive filling in Gombricc, 2012, p.81*

The most monumental sets of azulejos are those named "*de caixilho*" (transl: "framed azulejos"), found in several Christian temple interiors, lining the inner walls such as in Marvila Church, Santarém (1617-1620), immediately followed by the already mentioned azulejos "de tapete". The ones that we also see in Marvila over the large arch of the choir are derived from geometric patterns simply invented during the late 16th century already seen. Now they become more adapted to the surfaces in a repetition mood, giving a sense of largeness (1635-1639). The "de tapete" azulejos, usually form panels of 12x12 tiles.

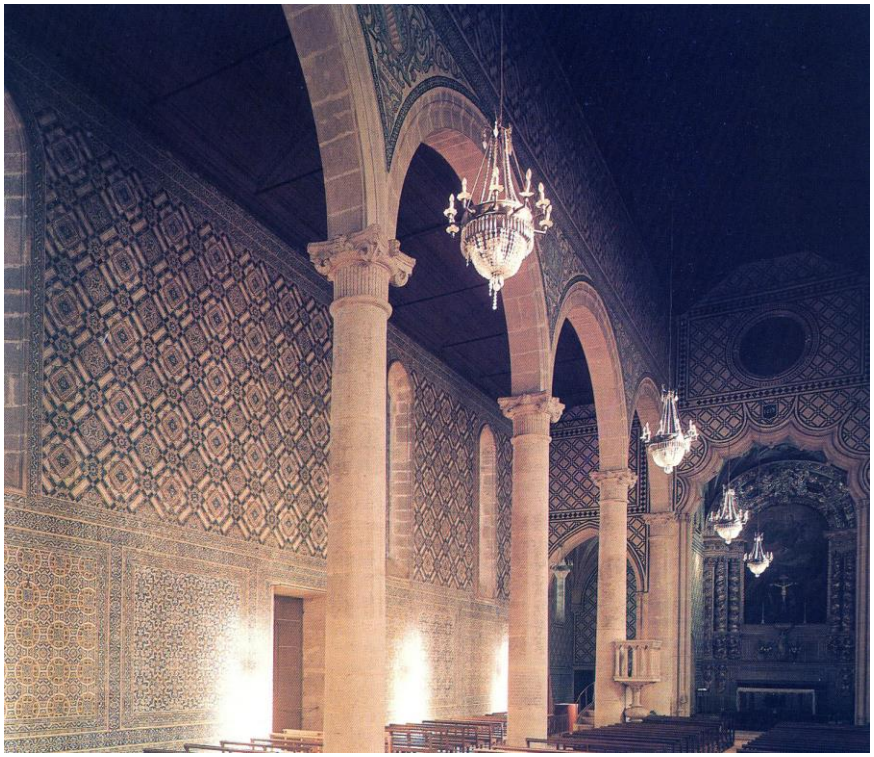


*Figure 91 Azulejos in Marvila Church, Santarém (Pannels from 1617-1620/1635-1639)*

*Figure 92 "Tapete" azulejos in Misericórdia de Óbidos. The first hall of the 17th century.*

*Figure 93 Patterned azujejos in Misericórida church in Vila do Conde, 17th century.*

Besides the already explained peculiarities of the drawing of geometrical patterns in glazed tiles, we wish to stress that, it is from the very nature of the "azulejo" to act at the *level of the senses.* Its potency derives from the perceptive experiences that can be caused, if we wish, not only because of a inner message concerned directly with religion and theological and philosophical endeavor intimately entwined within Islamic art, but also as a psychological powerhouse, something that can be expressed by the works of such art historians such as Enrst Gombrich or Andreas Speiser.

Having in mind the patterned model of Islamic doctrine, one can also analyses de repertoire of Portuguese "azulejo" trying to capture its psychological reality.

Because we can find here and in the other examples shown above three fundamental laws of decorative drawing as sated by Speiser: translation (in the cosmic sense); rotation and reflection. They result from the Euclidian

basics, but in the registered examples (simple ones at best) we can see that the use of a **ruler/straight line**, is subjected to a *rotation* within a central axis: from then on, the result obtained is the *reiteration of the initial form itself*, giving us a centered radiated pattern which reflects one of its halfs. (Gombrich, 2012)

The entwining of these themes brings to a perception "restlessness" or, on the contrary, of "rest". The expectation of regularity that defines human vision raise the need of an "inspection" of the decorative surfaces: attention is not needed, but in a way, every time that a pattern is broken by the beginning of a different patterns, that the inspection game resumes, and so on, in a chain of attention/distraction that gives an animated value to the wall.

That is the case of "tapete" azulejos, where there is what we might call an infinite organization within the frames, as if the decoration itself was a part of an episode of a vast *cosmic infinite fabric*. (Pereira, 2005; Gombrich, 2012)

*Figure 94 Monochromatic pattern, Convento de Odivelas. 17th century.*

The "tapete" panels, when using the variation of three main colors (white/blue/yellow), gives also to our gaze this need of inspection. Sometimes the colors act as negative/positive of each other, contrasting over the plain ground in which the themes are drawn: here we can "catch" by surprise a tendency for "pregnancy" and perceptual ambiguousness. The change in yellow/blue or in blue/white combinations of crochets and flowers is the mainstay of this kind of continuity in visual perception, in which monotony and variation have the same value.

"*Pattern-making in its most general form may be characterized as an ordering of elements by identity and difference. The pattern-maker often enjoys creating classes of motifs which are like in one respect and different in another. Coloring is his most elementary device in achieving this end. The squares of the chequerboard are identical in shape but not in color, and the designer is free to vary this difference across the board in any combination he chooses. Again, there is no limit to the permutations; he may inscribe circles into some of his squares and reverse the color relationship, some circles red on blue ground and others blue on red. Using an asymmetrical motif instead of the circle he may also vary or reverse its orientation systematically*." (Gombrich, 2012)

*Figure 96 "Tapete" azulejos pannel from the mid 17th cent. (Museu da Cidade, Lisbon)*

We must stress that the symbolism of the *center* and that of the *labyrinth* or *maze* is present throughout. Symmetrical stability gives us quietness and contemplation. In a sense, anyone can experiment in opening and then closing his eyes, trying to reconstruct mentally the former image…. However, if you "catch" the shape quite well you can remember it: and this phenomena is something akin of Islamic glazed tiles: it provides a *mental "place"* to build your own self, and *individuate* yourself in a manner not far from the exercises of the mystics, namely of the Sufi masters…

There is also a homology between these themes and the *mandala* effect. The patterned themes on the "tapete" azulejos as well as many or all of the Islamic patterned glazed tiles if caught within a cultural and religious framework can be understood in a larger and polysomic manner.

"*The restrictions are more obvious in the case of uniform grids or 'lattices' which are confined to triangles, squares, rhomboids or hexagons (…)*
*It is characteristic of these lattices that they can be infinitely extended on ali sides in a continuous pattern. Filling their shapes with elements, we can now study the number of symmetrical relationships we can produce by translation and rotation. Starting from an elementary asymmetrical unit and proceeding to the generation of further symmetries (…)*" (Gombrich, 1978)
To Carl Jung, the mandala acts as a "unidentified psychix center". And we know that is acts as a mean od mental exercise, raises he question of a physiology of the "mind" and of a "technique'.

As Chueca Goitia puts it: "El lazo revela major que nada su sutileza geometrica, su sabiduria para cpmponer tramas lineales con trazados gemetricos que pueden sucederse ad infinitum, como la imagen de un mundo estatico, abierto y recurriente. El atomismo religoso de los axaries se expresa aqui como la imagen de un proceso intemporal, de un tiempo

no fluyente sina congelado en una suma de instantes. El musulman contemplando passivamente este esquerma no se sentia acuidado por el paso del tiempo sino en cierto modo en un plano superado de su transcurso". The same could be said about the "tapete" motifs.

CHAPTER 8

# PARAMETRIC ENVISION TO ISLAMIC GEOMETRIC PATTERNS

# 8. PARAMETRIC ENVISION TO ISLAMIC GEOMETRIC PATTERNS

## 8.1 Graphical analyses of patterns

### 8.1.1 Six-folded geometry

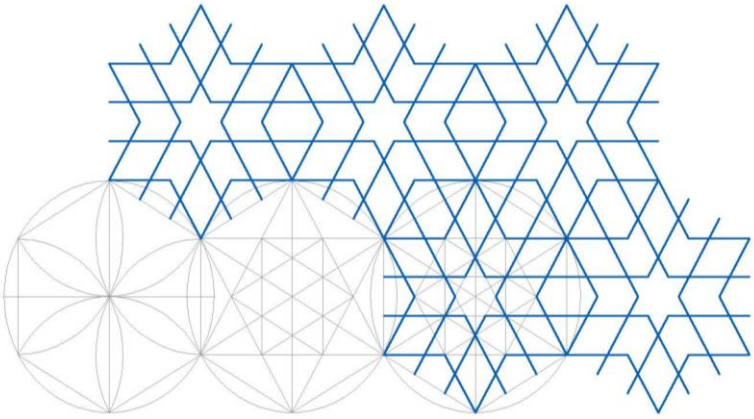


*Figure 97 Pattern A: From the Mausoleum of Yusiph ibn Kuseir*

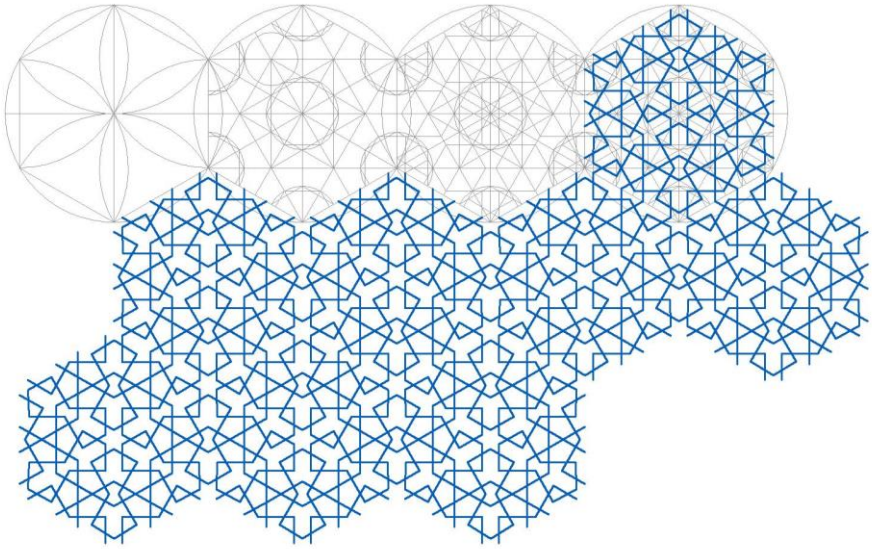


*Figure 98 Pattern B: From the Mausoleum of Yusiph ibn Kuseir*

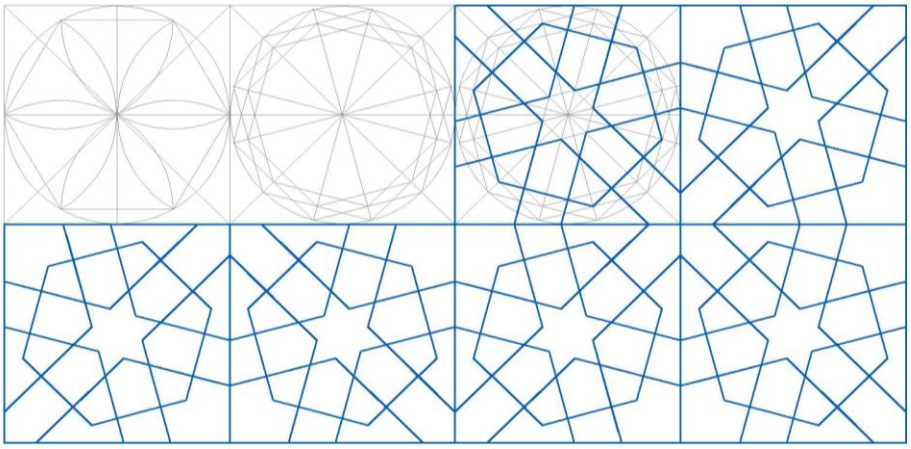


*Figure 99 Pattern C: From the Mausoleum of Yusiph ibn Kuseir*

## 8.1.2 Eight-folded geometry

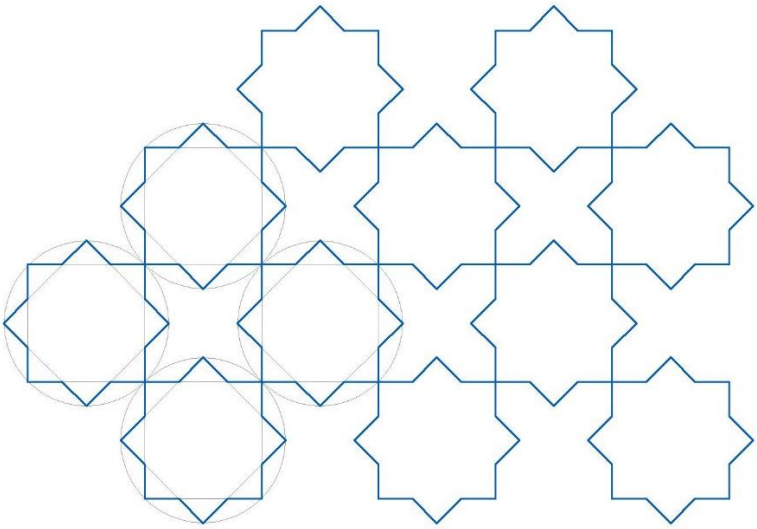


*Figure 100 Pattern D: From the Mausoleum of Yusiph ibn Kuseir*

## 8.2 Laser cut of the patterns

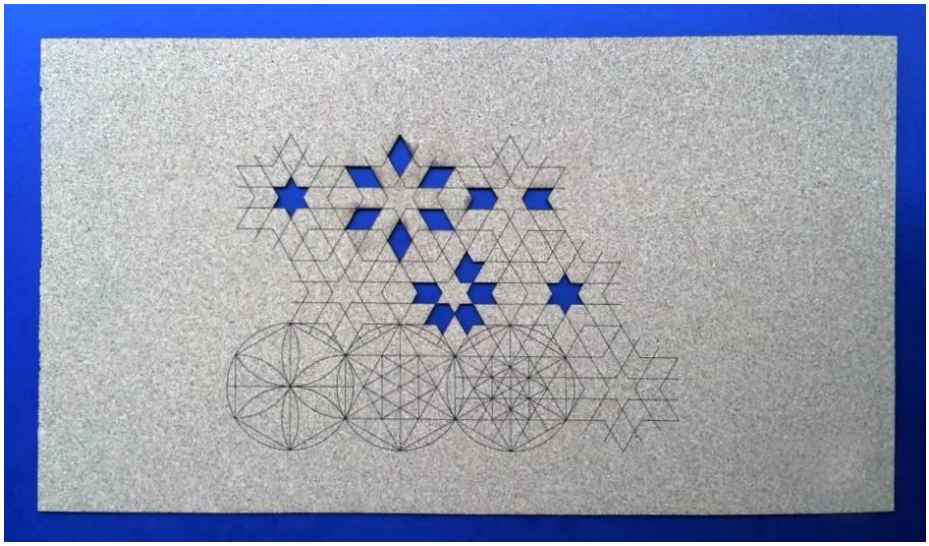


*Figure 101 Laser cut of the pattern A: From the Mausoleum of Yusiph ibn Kuseir*

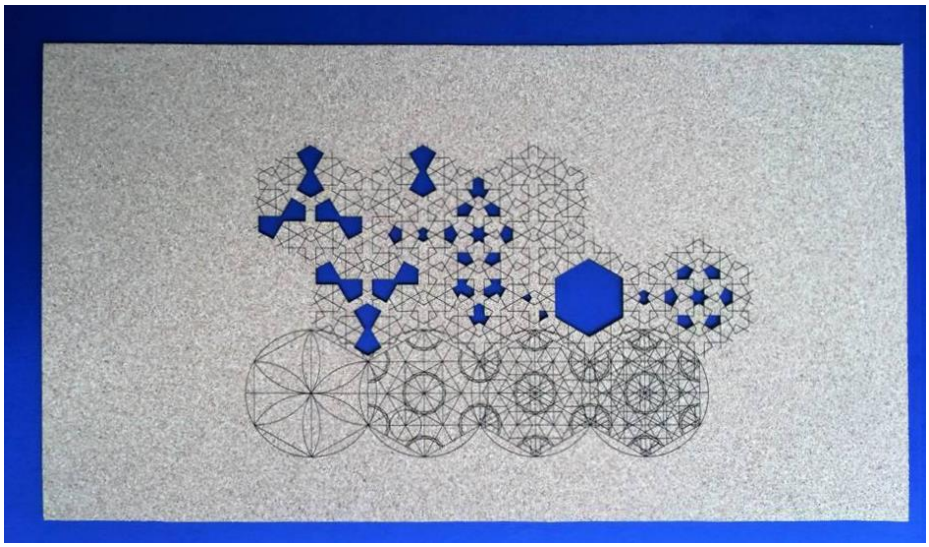


*Figure 102 Laser cut of the pattern B: From the Mausoleum of Yusiph ibn Kuseir*

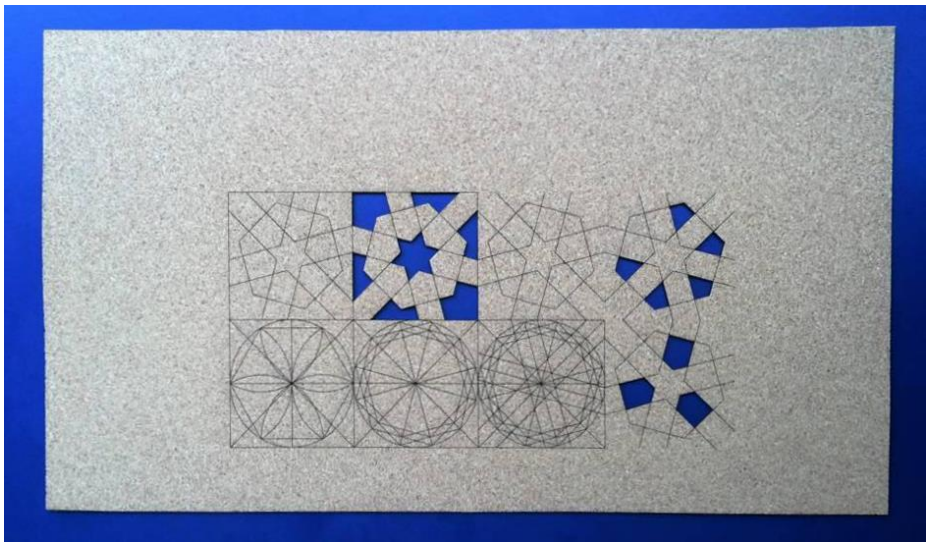


*Figure 103 Laser cut of the pattern C: From the Mausoleum of Yusiph ibn Kuseir*

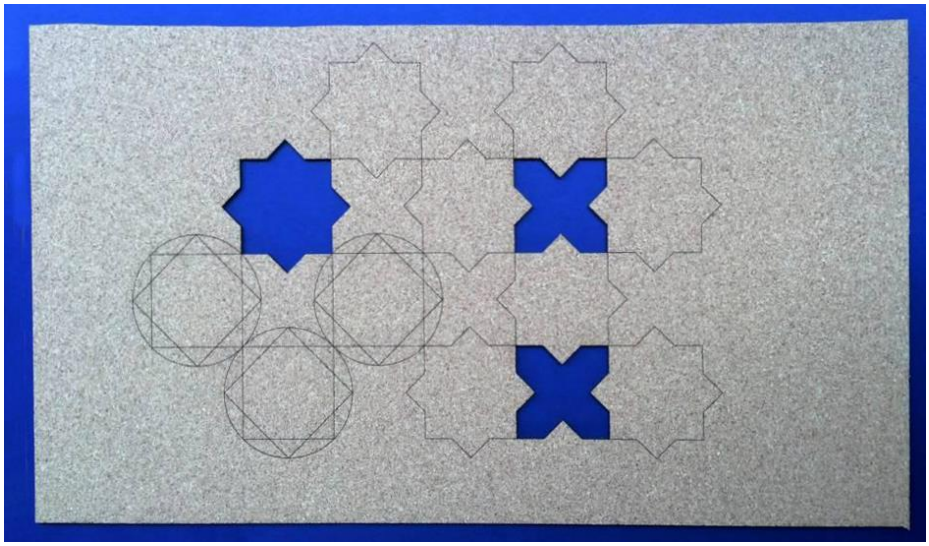


*Figure 104 Laser cut of the pattern D*

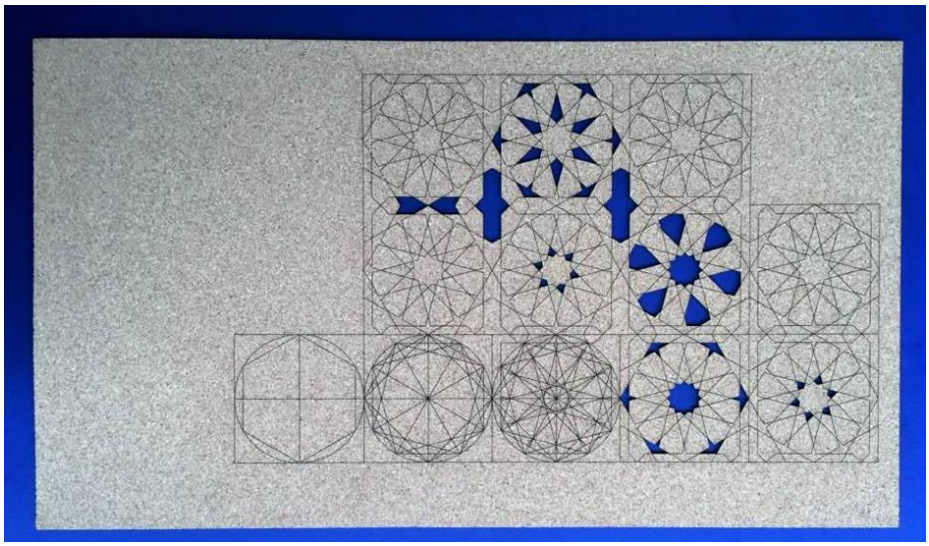


*Figure 105 Laser cut of the pattern E*

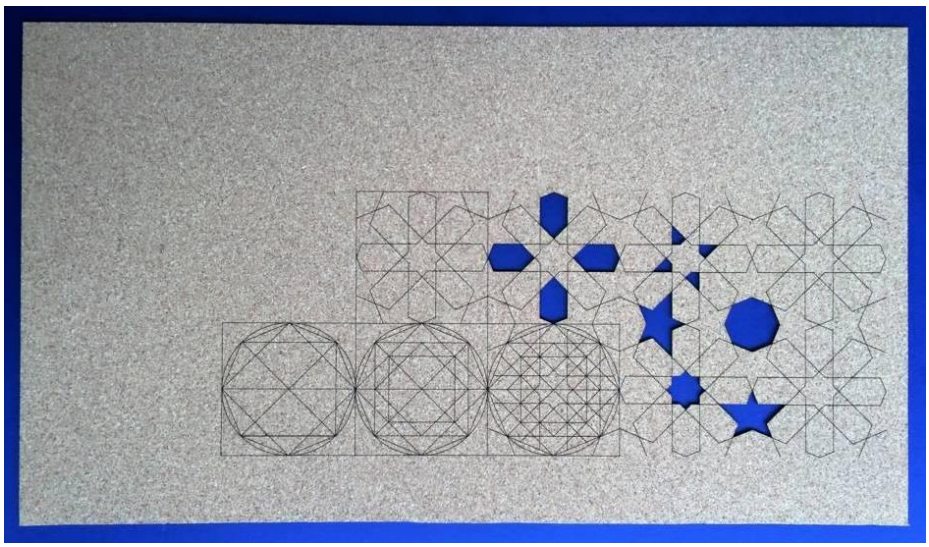


*Figure 106 Laser cut of the pattern F*

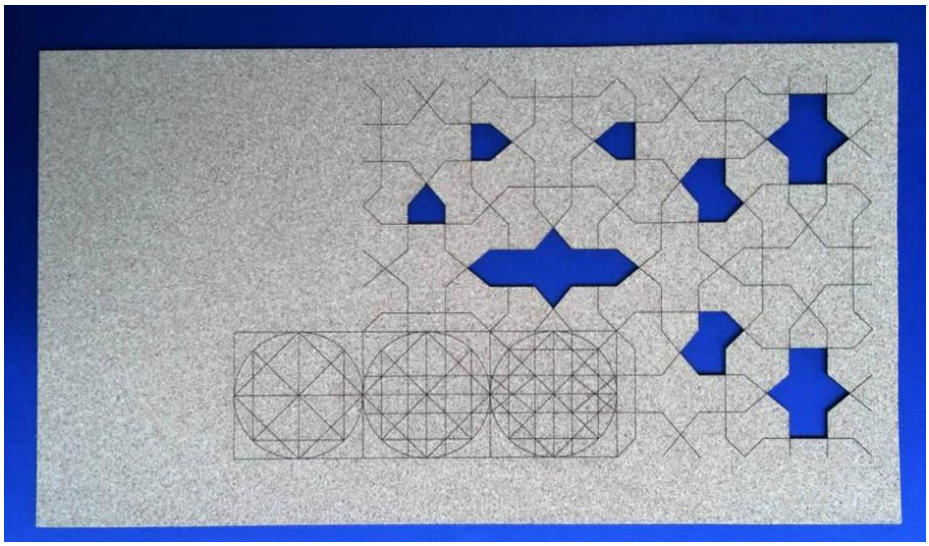


*Figure 107 Laser cut of the pattern G*

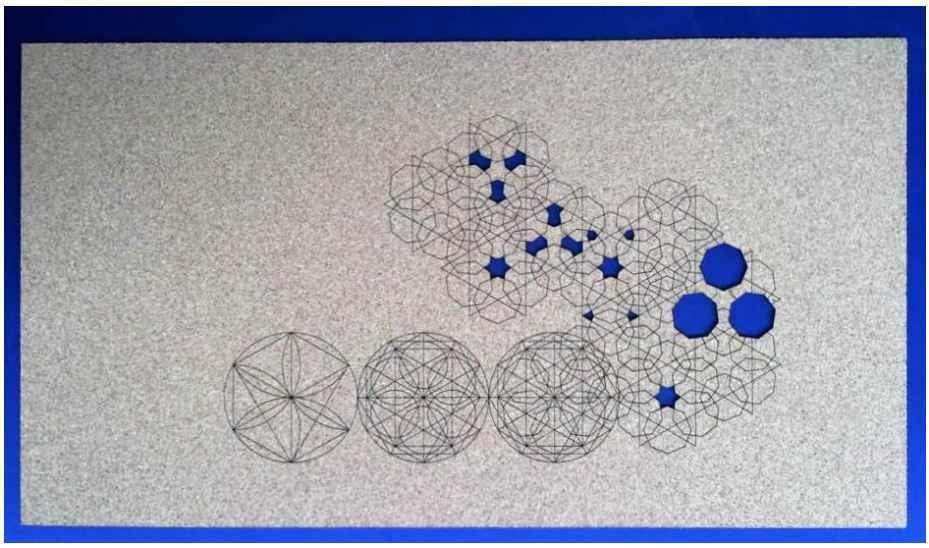
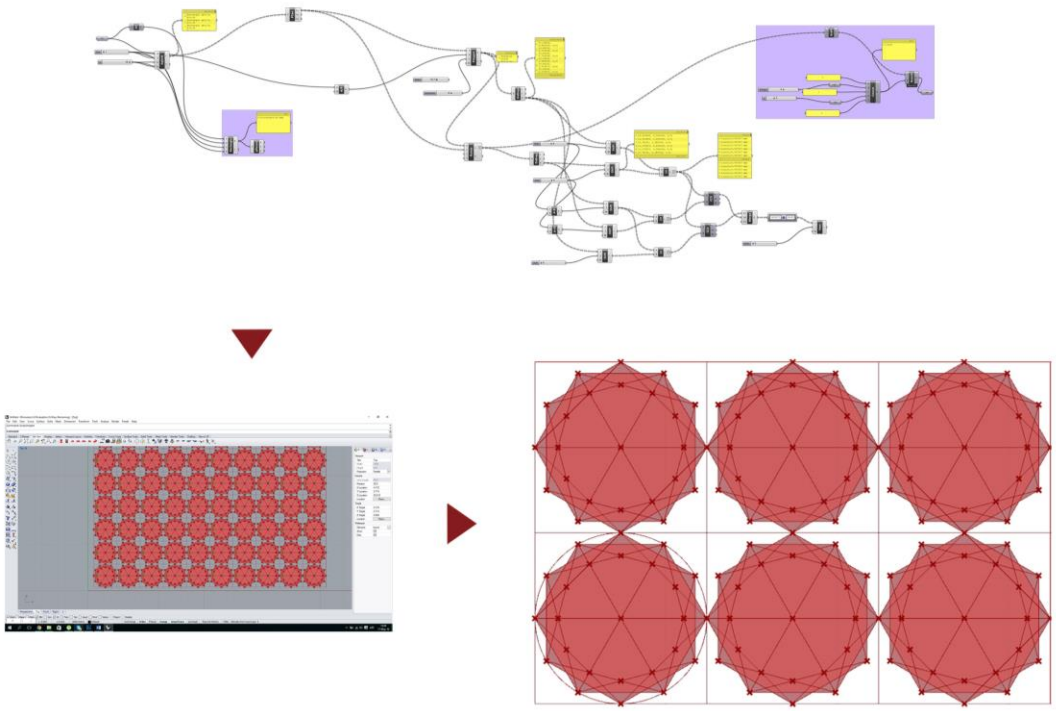
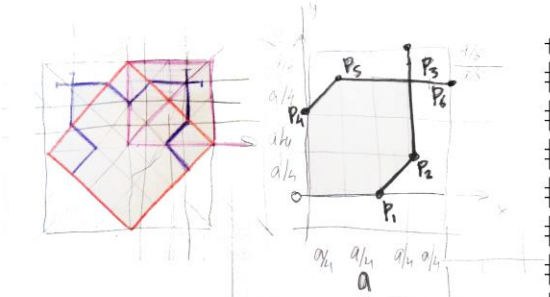


*Figure 108 Laser cut of the pattern H*

## 8.3 Definition of an universal code for patterns (Grasshopper + Rhinoceros)



## 8.4 Pattern defined by programming language "Doctor Racket"




*Sketches (Dividing the patten into parts, chosing a module, defining the points)*

```
#lang racket
(require (planet aml/rosetta))
(backend autocad)


(define (quarter-pattern p dx dy r)
(let* ((p1 (+x p (/ dx 2)))
       (p2 (+xy p1 (/ dx 4) (/ dy 4)))
       (p3 (+xy p (/ (* dx 3) 4) dy))
       (p4 (+y p (/ dy 2)))
       (p5 (+xy p4 (/ dx 4) (/ dy 4)))
       (p6 (+xy p dx (/ (* dy 3) 4))))
  (union
   (sweep (line p1 p2 p3)
          (surface-circle (u0) r))
   (sweep (line p4 p5 p6)
          (surface-circle (u0) r)))))
```

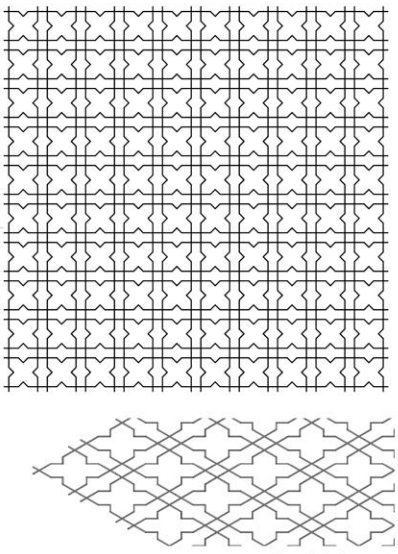
```
(define (pattern p d a r)
 (move
  (rotate
   (union
    (quarter-pattern (u0) d d r)
    (quarter-pattern (u0) (- d) d r)
    (quarter-pattern (u0) d (- d) r)
    (quarter-pattern (u0) (- d) (- d) r))   a)  p))

(define (bigger-pattern p d r)
 (union
  (pattern p d 0 r)
  (pattern (+x p (* 2 d)) d pi/2 r)
  (pattern (+y p (* 2 d)) d pi/2 r)
  (pattern (+xy p (* 2 d) (* 2 d)) d 0 r)))

(define (surface-pattern p l r n)
 (map-division (lambda (x y)
                 (bigger-pattern (+xy p x y) (/ l n 4) r))
               0 l n
               0 l n))

(surface-pattern (xy 1 1) 10 0.01 4)
```

*Code in DrRacket language*



*Results in Autocad*

# CONSCLUSION

# CONCLUSION

During the research we have revealed that Islamic geometric patterns have simple strict rules for creation andhave an infinite number of possible patterns. The same techniques of patterns creation are observed in every different place of applying.

When we studied patterns in Portugal and Azerbaijan we noticed for now just one exactly same pattern, all others, of course, have similarities at the construction of geometry, numbers of Leafs in the pattern. See Figure 100 pattern D. This pattern is he one of the most simple ones, and uses in many countries along with Potugal and Azerbaijan.

The first use of Islamic geometric patterns in Azerbaijan is dates to XII century and the first geometric patterns in Portugal in XV century. This difference in époques also leads to difference in techniques and places of applying but the main principal remains the same.

In Azerbaijan, we have observed the first patterns in Nakhchivan in mausoleums decorations. The technique used there was stone decoration with glazing. Later XV century patterns we observe in stone decoration of Baku. Later patterns become more colorful, they were used to create interior decorations and in colorful stained glass windows “shebeke”.

In Portugal the first appearance of Islamic geometric patterns was observed in azulejos dated t XV century and later, which were imported from Spain. Later we see elements of those patterns in floor and wall decorations, made by Moorish artisans. In addition, one of the most interesting examples of Islamic geometric patterns use is alfarje roof decorations.

Now Islamic geometric patterns in Portugal could be observed even in churches, while in Azerbaijan it still remains its importance in Islamic architecture.

Nowadays Islamic geometric patterns are popular in touristic use in Azerbaijan. They emphasize the Azerbaijan's oriental flavor and represents something different and original for tourists. In the construction of new building, especially building on the preserved area in the Old city in Baku, architects still use those geometric patterns.

Meanwhile as the Azerbaijan use those patterns to retain its history and attract tourists, in Portugal this part of history seems disappeared in modern life, art and architecture.

As Azerbaijan is still a country with the majority of population of Muslims, this topic was more actual there. However, there can be found new possibilities of those geometric patterns use also in Portugal.

At the same time with conservation, restoration and researching of existed Islamic geometric patterns, we should go on with the developing and improving new types and techniques of applying Islamic geometric patterns to modern architecture and life. This new developed projects should be useful as well for the both countries: Portugal and Azerbaijan.

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